FEMI.207:060048

SEP 1 7 1982

# FLOOD INSURANCE STUDY

ORIGINAL

COMPLETED
72

## CITY OF
## FRESNO,
## CALIFORNIA
FRESNO COUNTY

SEPTEMBER 16, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER-060048

## TABLE OF CONTENTS

Page

1.0 INTRODUCTION .......... 1

1.1 Purpose of Study .......... 1
1.2 Authority and Acknowledgments .......... 1
1.3 Coordination .......... 1

2.0 AREA STUDIED .......... 2

2.1 Scope of Study .......... 2
2.2 Community Description .......... 4
2.3 Principal Flood Problems .......... 6
2.4 Flood Protection Measures .......... 7

3.0 ENGINEERING METHODS .......... 10

3.1 Hydrologic Analyses .......... 10
3.2 Hydraulic Analyses .......... 11

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS .......... 15

4.1 Flood Boundaries .......... 15
4.2 Floodways .......... 16

5.0 INSURANCE APPLICATION .......... 18

5.1 Reach Determinations .......... 18
5.2 Flood Hazard Factors .......... 19
5.3 Flood Insurance Zones .......... 19
5.4 Flood Insurance Rate Map Description .......... 22

6.0 OTHER STUDIES .......... 22

7.0 LOCATION OF DATA .......... 23

8.0 BIBLIOGRAPHY AND REFERENCES .......... 23

## TABLE OF CONTENTS (Cont'd)

Page

### FIGURES

Figure 1 - Vicinity Map........................................ 3
Figure 2 - Historical Flooding................................. 8
Figure 3 - Historical Flooding................................. 8
Figure 4 - Historical Flooding................................. 9
Figure 5 - Floodway Schematic.................................. 18

### TABLES

Table 1 - Summary of Discharges................................ 12
Table 2 - Floodway Data........................................ 17
Table 3 - Flood Insurance Zone Data............................ 20

### EXHIBITS

Exhibit 1 - Flood Profiles

| | |
|---|---|
| Central Canal | Panel 01P |
| Dry Creek | Panels 02P-03P |
| Dry Creek Canal | Panels 04P-06P |
| Fancher Creek Canal | Panels 07P-08P |
| Herndon Canal | Panels 09P-13P |
| Mill Ditch | Panels 14P-15P |
| San Joaquin River | Panels 16P-19P |

Exhibit 2 - Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

**PUBLISHED SEPARATELY:**

Flood Insurance Rate Map Index
Flood Insurance Rate Map

# FLOOD INSURANCE STUDY

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Fresno, Fresno County, California, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Fresno to the regular program of flood insurance by the Federal Emergency Management Agency. Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 24 CFR, 1910.1(d). In such cases, however, it shall be understood that the State (or other jurisdictional agency) shall be able to explain these requirements and criteria.

### 1.2 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers, Sacramento District for the Federal Emergency Management Agency, under Inter-Agency Agreement No. IAA-H-10-77, Project Order 24, Amendment 1, and Inter-Agency Agreement No. IAA-H-9-79, Project Order 32, Amendment 1. This study was completed in March 1981.

### 1.3 Coordination

Efforts to obtain basic data needed for this Flood Insurance Study were initiated in August 1977, when a notice of study initiation containing a request for pertinent data was mailed to selected addresses. An announcement of the intent to perform flood elevation studies in Fresno County was published in the Fresno Bee on September 16, 23, and 30.

Requests for information were made with representatives of the U.S. Water and Power Resources Services (formerly the U.S. Bureau of Reclamation); the U.S. Geological Survey; the U.S. Soil Conservation Service; Fresno County; and the City of Fresno. The California

Departments of Fish and Game, Transportation, and Water Resources; the State Reclamation Board; Central Valley Irrigation District; Fresno Irrigation District; Fresno Metropolitan Flood Control District; Kings River Conservation District; and the Lower San Joaquin Levee District were also contacted.

A combined precontract and initial coordination meeting was held in Fresno on April 7, 1976. In attendance at this meeting were representatives of various local agencies, Fresno County, the State of California, the Soil Conservation Service, the Federal Emergency Management Agency, and the study contractor. The concept of flood insurance, in general, and the Flood Insurance Study for Fresno, in particular, were discussed; lines of communication were established; information on study procedures and methods, types of data required, study data application, and floodways and their determination was presented; and the streams and areas to be studied by detailed and approximate methods were identified.

An intermediate coordination meeting attended by representatives of the Federal Emergency Management Agency, the study contractor, Fresno County, the City of Fresno, and interested Federal and state agencies was held on October 8, 1980. The purpose of the meeting was to review technical data relevant to this Flood Insurance Study.

The final coordination meeting was held on March 10, 1982, and was attended by representatives of the Federal Emergency Management Agency, the study contractor, and the city. All problems raised at the meeting have been resolved.

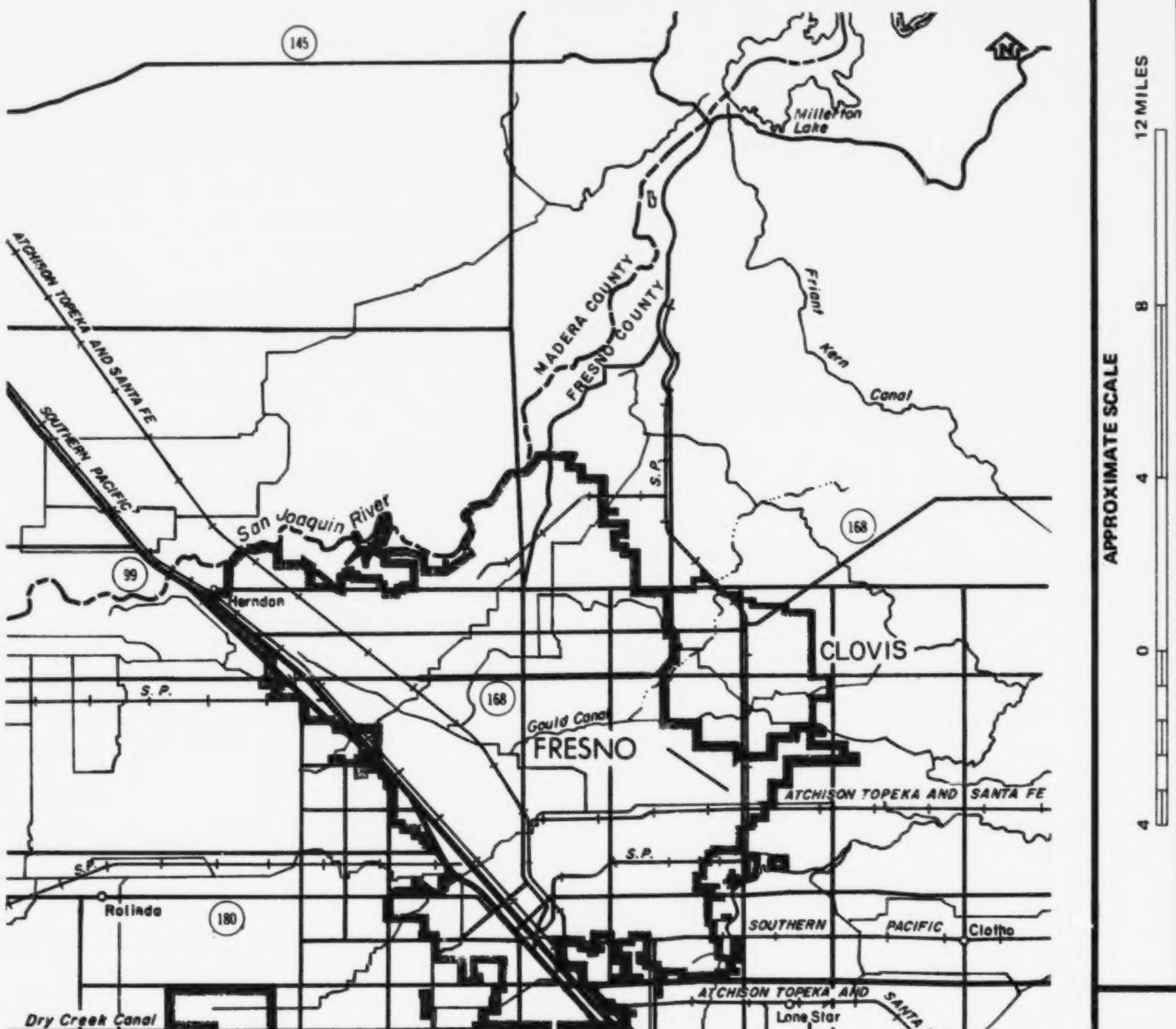
## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Fresno, Fresno County, California. The area of study is shown on the Vicinity Map (Figure 1).

Flooding along Central Canal, Dry Creek, Dry Creek Canal, Fancher Creek Canal, Herndon Canal, Mill Ditch, and San Joaquin River were studied by detailed methods.

Small localized drainage depressions and retention basins; the area bounded by East Ashland Avenue on the north, North Winery Avenue on the east, East Dakota Avenue on the south, and Dry Creek on the west; and along State Highway 41 were studied by approximate methods.


145
Millerton Lake
Friant Kern Canal
ATCHISON TOPEKA AND SANTA FE
SOUTHERN PACIFIC
MADERA COUNTY
FRESNO COUNTY
San Joaquin River
S.P.
168
99
Herndon
CLOVIS
S.P.
168
Gould Canal
FRESNO
ATCHISON TOPEKA AND SANTA FE
S.P.
S.P.
Rolinda
180
SOUTHERN PACIFIC
Clotho
ATCHISON TOPEKA AND SANTA FE
Lone Star
Dry Creek Canal
MALAGA
Central Canal
ATCHISON TOPEKA AND SANTA FE
DEL REY
FOWLER
Wristen Canal
Bowles
Raisin City
41
99
SELMA
CARUTHERS
Elkhorn Ditch
Conejo
Wildflower
43
S.P.
Burrel
Industrial Farm
APPROXIMATE SCALE
4
0
4
8
12 MILES

VICINITY MAP

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

FIGURE 1

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1986.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the Federal Emergency Management Agency, the City of Fresno, and Fresno County.

## 2.2 Community Description

The City of Fresno was originally established in April 1860 along both banks of Fresno Slough about 1 to 2 miles northwest of the present Town of Tranquillity. The present city was started in April 1872 as a station on the Central Pacific (now Southern Pacific) Railroad. Residents of the first settlement relocated to the newer site due to its proximity to the railroad. The city is situated in north-central Fresno County in central California, and is adjacent to Clovis on the northeast; unincorporated Fresno County on the east, south, and west; and Madera County on the north.

Fresno became the county seat in March 1874 and was incorporated in October 1885. Early economic endeavors were devoted mainly to growing field crops. Then, as irrigation was introduced and became widespread, vineyards and orchards were established and row crops introduced. The city's economic base has always been agriculture, but commercial and industrial development, related and unrelated to agriculture, has increased tremendously. About 70 percent of the manufacturing plants in the county are located in Fresno. Some of the leading product groups are: farming implements, agricultural sprinkler systems, light machinery, sheet glass, agricultural chemicals, and transportation equipment. Included as part of the industrial sector are machine shops, industrial supply firms, foundries for various metals, and public warehouses. Food processing and packing continues as an important element of the economic structure of the city. The population of Fresno was approximately 194,800 in 1979 (Reference 1).

Topography in Fresno is characterized by broad, flat valley floor land that gently slopes from southeast to northwest.

San Joaquin River flows west along the northern corporate limits of Fresno, forms most of the county's northern boundary and is the principal stream in the southern half (San Joaquin Valley) of the Central Valley. Its main headwater tributaries, the south and middle forks, rise in glacial lakes in Fresno and Madera Counties in the southern Sierra Nevada. The forks join at an elevation of approximately 3,600 feet to form the main stem, which flows west-southwesterly to the valley floor, westerly for about 25 miles, then northwesterly down the main trough of the Central

Valley to its junction with Sacramento River and its terminus at Suisun Bay.

The headwaters of Dry Creek originate in the Sierra Nevada foothills just northwest of Friant-Kern Canal at an elevation of approximately 500 feet in north-central Fresno County. Dry Creek flows southwesterly for approximately 16 miles to its confluence with Herndon Canal in the City of Fresno.

Central Canal flows southwest through the southeastern part of Fresno.

Dry Creek Canal begins at the confluence of Mill Ditch and Herndon Canal, just downstream of North Millbrook Avenue, and flows southwest through the southwestern portion of the city.

Fancher Creek Canal flows southwest along the eastern corporate limits of Fresno, and joins Central Canal at the southeast corner of the city.

Herndon Canal begins at the confluence of Mill Ditch and Dry Creek Canal. It flows west through the center of Fresno, then flows northwest through the northwestern part of the city.

Mill Ditch flows west along East McKinley Avenue to its confluence with Herndon Canal and Dry Creek Canal.

Except for the San Joaquin River, streams in the Fresno-Clovis area extend into the valley floor west of State Highway 99 by way of dual-use irrigation and storm runoff channels and disperse into numerous smaller irrigation canals.

There are only two distinct seasons in Fresno, summer and winter. Summers are long, hot, and dry in the lower elevations of the San Joaquin Valley. Temperatures in the Fresno area range from average winter lows of about 37°F to average summer highs of about 100°F, but extremes of 18° in winter and 114°F in summer have been recorded. Wintertime temperatures may drop below freezing for a few hours of several consecutive days, but extended periods of freezing weather do not occur. Daytime temperatures during summer may exceed 100°F for extended periods.

There is practically no precipitation during the summer. Winters are short and mild with relatively light rainfall. Normal annual precipitation varies from approximately 6 inches in the western part of the San Joaquin Valley to approximately 20 inches in the Coast Ranges. Most of the seasonal precipitation occurs from October through April.

Native vegetation in the Fresno area has been essentially obliterated by agricultural operations and urbanization.

## 2.3 Principal Flood Problems

General rainfloods can occur in Fresno anytime from November through April. This type of flood results from prolonged heavy rainfall over tributary areas and is characterized by high peak flows of moderate duration. Flooding is more severe when antecedent rain has resulted in saturated ground conditions, when the ground is frozen and infiltration is minimal, or when rain on snow in the high elevations on the east side adds snowmelt to rainflood runoff.

Snowmelt floods on San Joaquin River and its higher elevation tributaries can be expected to occur anytime from April through June. Although snowmelt flooding is of much larger volume and longer duration than rainflooding, it does not have the high peak flows characteristic of rainfloods. Snowmelt flood runoff is sometimes augmented by late spring rains on the snowfields or lower elevation tributary watersheds.

Cloudburst storms sometimes lasting as long as 3 hours can occur anytime from late spring to early fall, and may occur as an extremely severe sequence within a general rainstorm. Cloudbursts are high intensity storms that can produce floods characterized by high peak flows, short duration of floodflows, and small volume of runoff. In some areas of Fresno County, especially where drainage basins are small, cloudbursts can produce peak flows substantially larger than those of general rainstorms. Cloudburst storms usually cover small areas and would not affect floodflows or flood stage on San Joaquin River. Generally, only the upper reaches of the smaller streams are affected by cloudbursts.

In urbanizing areas, flood problems are intensified because open land available to absorb rainfall and runoff is being used for new homes; commercial and industrial structures; and driveways, sidewalks, streets, parking lots, and other paved areas. Thus, the decrease in open land increases the volume of water that must be carried away by waterways.

Fresno County has a long history of flooding, but little definitive data are available for specific floods, particularly on the lesser streams. Early historical floods occurred before streamflow records were made and contemporary accounts of floods are practically nonexistent. Information on past floods is based essentially on historical accounts, various published and unpublished reports, and newspaper articles. These sources indicate the probability of nine flood events in Fresno County from the 1840s to 1900. The earliest flood mentioned occurred in 1849, but no details are available. Floods are also known to have occurred in the region in 1847 and 1852. Floods that occurred during the winter of 1861-62 were the most severe known in California to that date - several separate flood periods occurred on San Joaquin Valley foothill streams during January 12-18, 1862. Flow on San Joaquin

River was judged to be the greatest known since early in the 19th Century. Flooding throughout the region in 1878 produced the last known discharge from the Tulare Lake Basin into the San Joaquin River Basin.

In February 1884, floodflows inundated the business section of Fresno. Frequent flooding was a problem in Fresno in the 1880s as evidenced by a February 9, 1887 edditorial in the Fresno Morning Republican that questioned:

> What are we going to do about it? For the past three winters portions of Fresno City have been flooded. . .

Suburban areas of Fresno were flooded in the spring of 1920; the downtown area was inundated in 1923; flooding occurred in the Figarden area in 1936; and parts of the city, especially in the northeast section, were flooded in March 1938. Since the 1938 flood, which had an estimated flow of 2,700 cfs on Dry Creek at the Big Dry Creek Dam site, high flows occurred on that stream in December 1955 (3,800 cfs), January 1969 (5,700 cfs), and February 1969 (4,500 cfs). The largest and most damaging flood period was January-February 1969 when the combined flows of Dry, Dog, Redbank, Fancher, and Mud Creeks flooded about 14,500 acres and caused almost $4.7 million in damages. Most of the flooding was in the east and northeastern parts of the city. It occurred because many of the streams in the Fresno-Clovis area discharged floodwaters into various irrigation canals causing them to overflow. During December 1955, about 500 acres of agricultural and suburban land were flooded by overflow from irrigation canals and damage - mostly to public facilities - totalled about $50,000. Figures 2 through 4 show historic flooding in Fresno.

## 2.4 Flood Protection Measures

Some flood protection is provided by Big Dry Creek Dam on Dry Creek, approximately 6.5 miles upstream of Fresno. Its main purpose is flood control, having a storage capacity of 16,250 acre-feet. Big Dry Creek Reservoir has prevented an estimated $15 million worth of damage in the Fresno-Clovis area.

Several main irrigation canals cross the natural east-west flow paths of streams in the valley floor and foothill areas east of Fresno. During floods, these canals also serve as conveyances directing excess storm runoff through the Fresno-Clovis area to agricultural land to the west.

A U.S. Army Corps of Engineers feasibility report on drainage basins east of the Fresno-Clovis area (Reference 2) includes a selected plan of improvement comprising a single-purpose reservoir on Fancher Creek, flood detention basins on Alluvial Drain and Redbank and Pup Creeks, and enlargement of the existing Big Dry

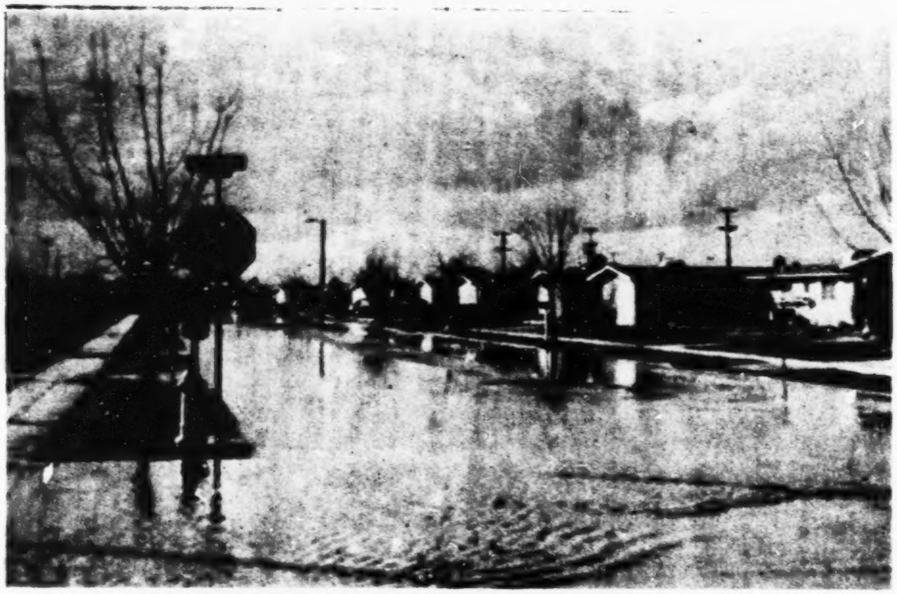


Figure 2. Southeast Section of Fresno, January 1969 Looking West on Lamona From Peach Avenue. (Photo Courtesy of U.S. Army Corps of Engineers).

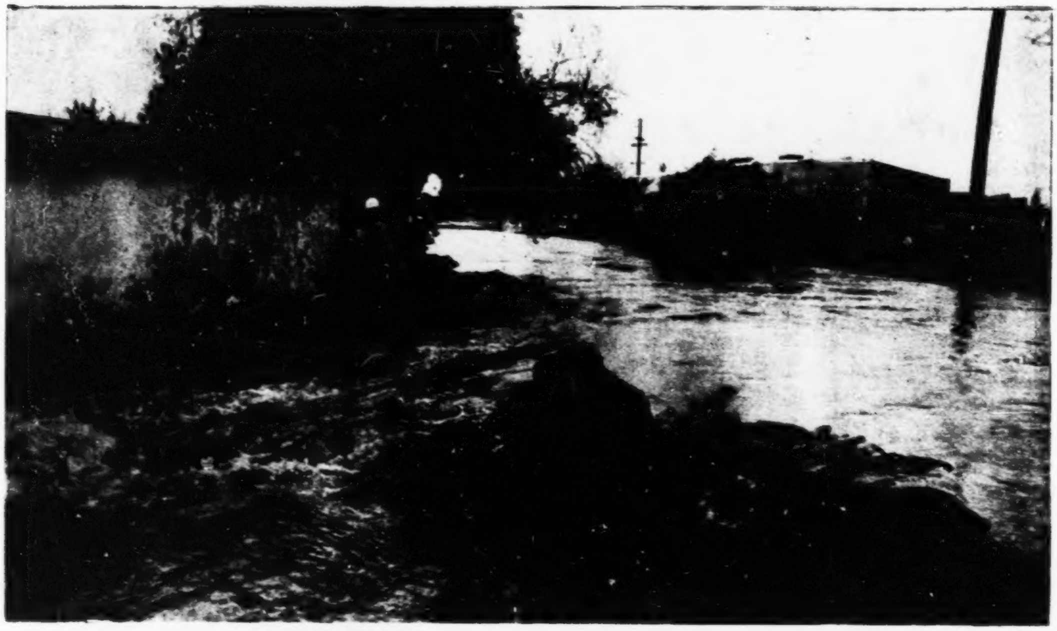


Figure 3. Dry Creek Canal Near Van Ness and Belmont Avenues, Fresno, January 25, 1969. (Photo Courtesy of the Fresno Bee).

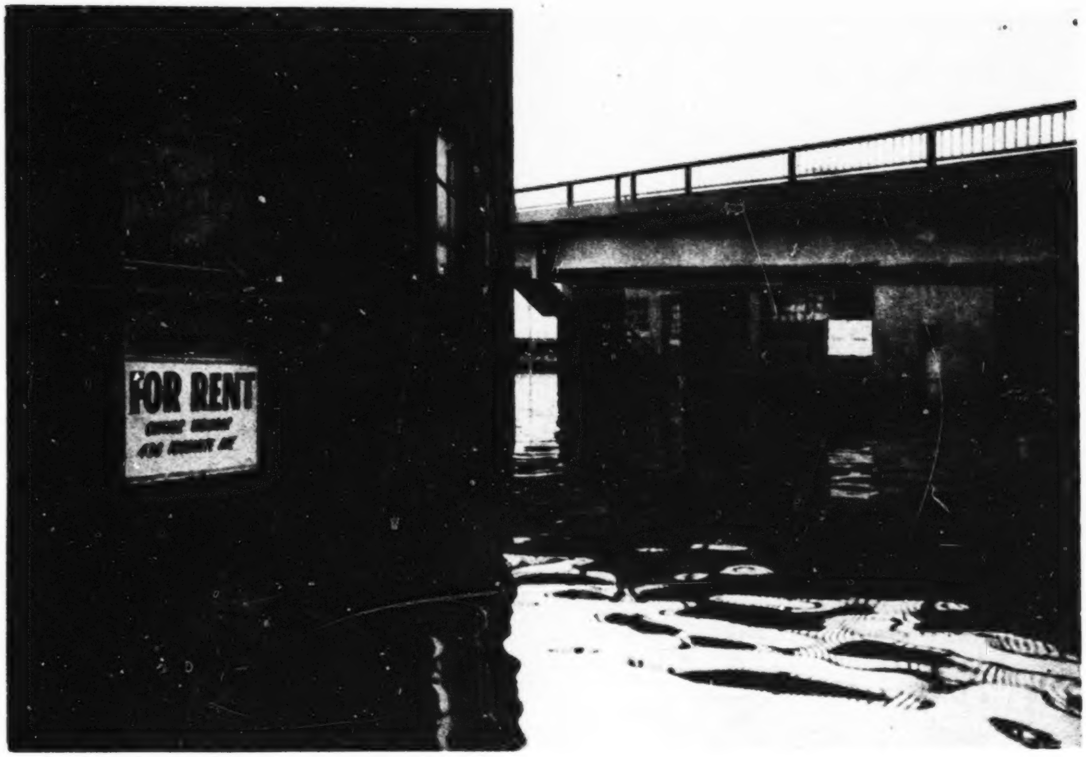


Figure 4. Floodwaters From Uncontrolled Streams to the East Inundated a Portion of Western Fresno (H Street Area) on January 25, 1969. (Photo Courtesy of the Fresno Bee).

Creek Reservoir. These improvements would provide a high degree of flood protection to about 45,000 acres of agricultural and urban lands.

## 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

### 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Flood estimates were determined from analyses of streamflow records (when available) or were synthetically derived from precipitation-runoff computations. Streamflow record analyses were accomplished in accordance with U.S. Water Resources Council guidelines (Reference 3). Procedures used included the U.S. Army Corps of Engineers standard project rainfall and flood concept and the unit hydrograph method of analysis (Reference 4). A standard project flood would result from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographic area in which the drainage basin is located, excluding extremely rare combinations. Both the 96-hour general rain and the 3-hour cloudburst standard project storms were evaluated. Precipitation amounts and distribution were computed using methodology described in the U.S. Army Corps of Engineers report on Standard Project Criteria for General and Local Storms (Reference 5). The unit hydrograph-excess rainfall method was used to compute flood hydrographs. Unit hydrographs were derived from reconstitutions of historical flood events based on streamflow data. Where no streamflow records were available, unit hydrographs were synthetically derived by using regional data and criteria. Generally, loss rates were based on data derived from flood reconstitutions and analyses of soil cover and land uses.

Floods for the selected recurrence intervals on San Joaquin River were computed from analyses of streamflow records. The U.S. Geological Survey stream gage on San Joaquin River near Mendota, with a period of record of 38 years (1939 to 1977) was used in the analysis.

General rainfloods other than the standard project flood on streams and canals in the Fresno area (except San Joaquin River) were computed from rainfall amounts based on a precipitation-frequency analysis of data from the National Weather Service precipitation station at Fresno Airport, with a period of record of 88 years.

Discharges on Dry Creek decrease with increasing drainage area due to excessive overbank losses based on limited channel capacity to convey floodflows equal to or greater than a 50-year event.

Discharges on Dry Creek Canal, Fancher Creek Canal, and Mill Ditch decrease downstream due to extensive overbank losses.

Summer irrigation releases on Dry Creek Canal, Fancher Creek Canal, Herndon Canal, and Mill Ditch are greater than the natural 10-year flood.

Peak discharge-drainage area relationships for all streams studied in detail are shown in Table 1.

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Water-surface elevations of floods of the selected recurrence intervals were computed through the use of the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 6).

Cross sections for backwater analyses were located at close intervals upstream and downstream from bridges, culverts, diversion structures, low water crossings, drop structures, and other hydraulically significant features in order to establish their backwater effect in areas presently urbanized or subject to development. Additional cross sections were located at other representative locations throughout the study area. Cross section data were derived from

Table 1. Summary of Discharges

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (Cubic Feet per Second) 10-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|
| Central Canal | | | | | |
| At State Highway 99 | --[1] | 350 | 350 | 350 | 350 |
| At North Avenue | --[1] | 380 | 380 | 380 | 380 |
| At Church Avenue | --[1] | 400 | 440 | 440 | 440 |
| Dry Creek | | | | | |
| At confluence with Herndon Canal | 24.3[2] | 330 | 390[3] | 390[3] | 390[3] |
| Downstream of Gould Canal | 22.3[2] | 210 | 470 | 470 | 470 |
| Dry Creek Canal | | | | | |
| At State Highway 99 | --[1] | 300[4] | 400[3] | 400[3] | 400[3] |
| At East Franklin Avenue | --[1] | 300[4] | 520 | 600[3] | 600[3] |
| At North Van Ness Avenue | --[1] | 300[4] | 520 | 650 | 700 |
| At North First Street | --[1] | 300[4] | 520 | 650 | 660 |
| At North Millbrook Avenue Drop Structure | --[1] | 300[4] | 520 | 650 | 660 |
| Fancher Creek Canal | | | | | |
| At East Butler Avenue | --[1] | 600[4] | 600[3] | 600[3] | 600[3] |
| At South Clovis Avenue | --[1] | 600[4] | 720[3] | 730[3] | 740[3] |
| At North Fowler Avenue | --[1] | 600[4] | 1,000[3] | 1,100[3] | 1,200[3] |
| At East Belmont Avenue | --[1] | 600[4] | 1,100[3] | 1,300[3] | 1,500[3] |
| At Fancher Avenue | --[1] | 600[4] | 1,500 | 1,800 | 3,300 |

[1] Not applicable; waterway is a distributary

[2] Drainage area downstream of Big Dry Creek Reservoir only

[3] Decrease due to excessive overbank losses upstream

[4] Normal irrigation releases exceed floodflow

Table 1. Summary of Discharges (Cont'd)

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (Cubic Feet per Second) 10-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|
| Herndon Canal | | | | | |
| At State Highway 99 | --[1] | 525[4] | 600 | 600 | 600 |
| At North Blackstone Avenue | --[1] | 525[4] | 600 | 600 | 600 |
| At East McKinley Avenue | --[1] | 525[4] | 600 | 600 | 600 |
| Mill Ditch | | | | | |
| At North Millbrook Avenue | --[1] | 825[4] | 900[3] | 900[3] | 900[3] |
| At North Fowler Avenue | --[1] | 825[4] | 1,000 | 1,800[3] | 2,500[3] |
| At Temperance Avenue | --[1] | 825[4] | 1,000 | 2,070 | 4,000 |
| At Fancher Avenue | --[1] | 825[4] | 900[4] | 900[4] | 1,000 |
| San Joaquin River | | | | | |
| At Atchison Topeka and Santa Fe Railroad | 1,785 | 8,000 | 13,800 | 19,800 | 95,000 |

[1] Not applicable; waterway is a distributary

[2] Drainage area downstream of Big Dry Creek Reservoir only

[3] Decrease due to excessive overbank losses upstream

[4] Normal irrigation releases exceed floodflow

field surveys and topographic maps (References 7 and 8). Field surveys were conducted to obtain structural data for bridges, dams, culverts, drop structures, diversions, and weirs.

Hydraulic roughness factors (Manning's "n") for hydraulic computations were assigned on the basis of field inspection of flood plain areas. The factors ranged from 0.030 to 0.080 for channels and from 0.030 to 0.100 for overbank areas.

Starting water-surface elevations were developed by the slope-area method, or taken from the main stem for tributary streams.

Some areas in Fresno are subject to broad, shallow, overland flooding generally less than 3 feet deep and characterized by unpredictable flow paths (sheet flow). The water-surface elevations of flooding in these areas are essentially independent of those along the adjacent waterways and are affected principally by natural and manmade barriers to flow in the flooded areas. Where sheet flow has reduced to a few hundred cubic feet per second and has spread to the extent that it is only a few inches deep, flooding was not followed out to its ultimate limit and may have been arbitrarily cut off at a natural or manmade barrier to flow.

The levee along the left bank of the diversion channel from Big Dry Creek Reservoir to Little Dry Creek would be overtopped during a 100-year flood and failure could occur anywhere along its entire length. Much of the flooding north of Herndon Canal in the northeastern and central parts of the city, and north of Dry Creek Canal in central and western Fresno reflect this levee failure.

Deep ponding (Zone A8) occurs in the area bounded by East Shaw Avenue to the south, North First Street to the east, North Sixth and North Bond Streets to the east. Deep ponding areas (Zones A8 and A10) also occur north of the Atchison Topeka and Santa Fe Railroad in the center of the city. These areas are the result of overland flooding from Dry Creek. Flooding from Herndon Canal and Dry Creek Canal also contribute flow to these areas.

Shallow flooding in the south-central part of the city is caused by overland flow from Mill Ditch and Fancher Creek Canal.

Areas of shallow flooding were determined by field investigation and by using the U.S. Army Corps of Engineers RATE Computer Program (Reference 4), which calculated the amount of breakout flow on streams throughout the study area. Depths were then determined using either normal depth or weir calculations where appropriate.

Flooding depths for approximate areas were determined by field investigation and topographic maps (Reference 8).

Levees in this study were analyzed using the U.S. Army Corps of Engineers RATE Computer Program (Reference 4).

The hydraulic analyses reflect unobstructed flow. Flood elevations shown on the profiles are thus considered valid only if hydraulic structures such as bridges and culverts remain unobstructed and existing dams and levees and other flood control structures operate properly and do not fail. Small earth dams placed across waterways to divert water for irrigation are assumed to fail (i.e., erode completely away) if overtopped by floodwaters.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in the study are shown on the maps.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

### 4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2400, with a contour interval of 1 foot (Reference 7) and at a scale of 1:9600, with a contour interval of 2 feet (Reference 8), and extensive field inspection.

Flood boundaries for those areas studied by approximate methods were delineated using topographic maps at a scale of 1:9600 (Reference 8).

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map for Fresno County (Reference 9).

Flood boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year flood boundary has been shown. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

## 4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the Federal Emergency Management Agency limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain.

The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

Floodways are not established for sheet flow and ponding areas or where floodflows are contained in conduits and canals; therefore, floodways were not determined for Central Canal, Dry Creek Canal, Fancher Creek Canal, Herndon Canal, or Mill Ditch. A floodway was not determined for Dry Creek due to excessive overbank losses.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH[2] (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| San Joaquin River | | | | | | | | |
| A | 245.270 | 438/280 | 5,176 | 3.8 | 240.9 | 240.9 | 241.9 | 1.0 |
| B | 245.494 | 554/280 | 9,056 | 2.2 | 241.3 | 241.3 | 242.3 | 1.0 |
| C | 245.740 | 320/120 | 6,060 | 3.3 | 241.4 | 241.4 | 242.4 | 1.0 |
| D | 245.986 | 563/110 | 6,708 | 3.0 | 241.7 | 241.7 | 242.7 | 1.0 |
| E | 246.180 | 555/100 | 6,526 | 3.0 | 242.0 | 242.0 | 242.9 | 0.9 |
| F | 249.152 | 480/130 | 5,245 | 3.8 | 251.5 | 251.5 | 252.3 | 0.8 |
| G | 249.552 | 477/150 | 6,109 | 3.2 | 252.2 | 252.2 | 253.1 | 0.9 |
| H | 249.924 | 400/350 | 2,981 | 6.6 | 253.1 | 253.1 | 254.0 | 0.9 |
| I | 250.106 | 420/120 | 4,484 | 4.4 | 253.9 | 253.9 | 254.9 | 1.0 |
| J | 252.547 | 1386/990 | 13,076 | 1.5 | 261.0 | 261.0 | 261.2 | 0.2 |
| K | 253.000 | 970/670 | 5,016 | 3.9 | 261.3 | 261.3 | 261.4 | 0.1 |
| L | 253.580 | 793/80 | 6,800 | 2.9 | 262.8 | 262.8 | 263.4 | 0.6 |
| M | 254.150 | 1230/540 | 7,304 | 2.7 | 264.4 | 264.4 | 265.3 | 0.9 |
| N | 254.515 | 440/300 | 4,883 | 4.0 | 265.9 | 265.9 | 266.9 | 1.0 |
| O | 254.720 | 600/270 | 7,600 | 2.6 | 267.5 | 267.5 | 268.2 | 0.7 |
| P | 255.076 | 1050/400 | 7,256 | 2.7 | 267.9 | 267.9 | 268.7 | 0.8 |
| Q | 255.675 | 650/220 | 4,901 | 4.0 | 269.5 | 269.5 | 270.1 | 0.6 |

[1] Miles Above Mouth [2] Width/Width Within Corporate Limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

## FLOODWAY DATA

**SAN JOAQUIN RIVER**

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 5.

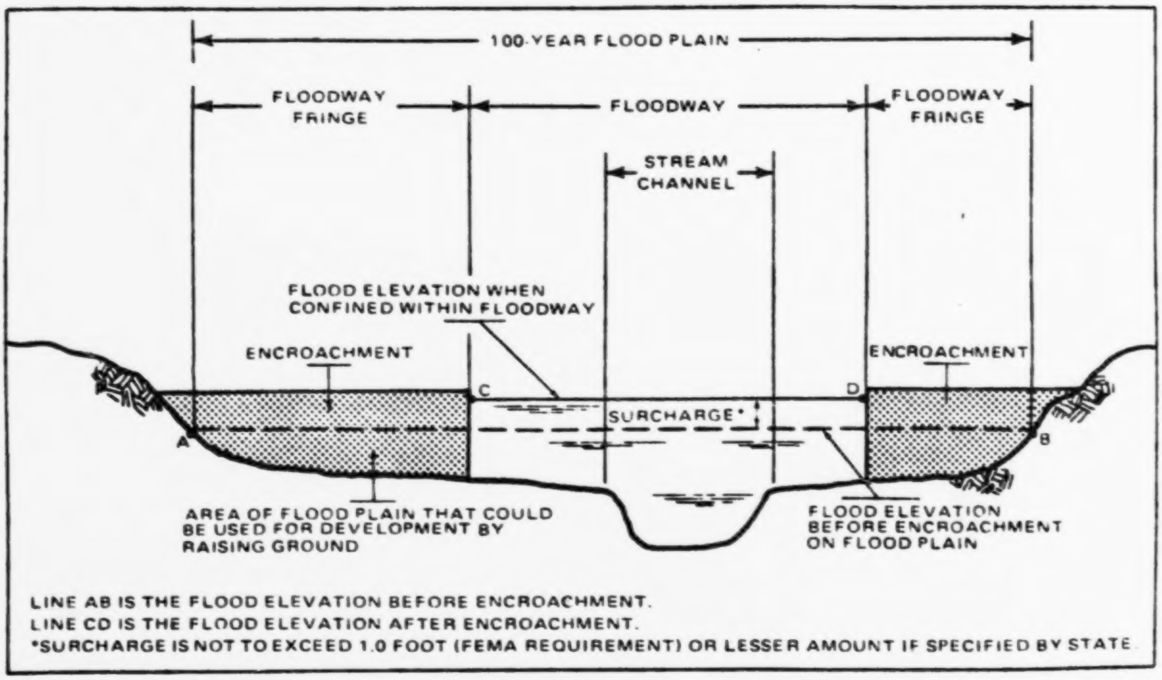

100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 5. Floodway Schematic

## 5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Emergency Management Agency has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source studied in detail affecting Fresno.

### 5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-Year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the flooding sources of Fresno are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

## 5.2 Flood Hazard Factors

The FHF is the Federal Emergency Management Agency device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

## 5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of Fresno was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

| | |
|---|---|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined. |
| Zone AO: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown, but no FHFs are determined. |
| Zone AH: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined. |

| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION (FEET NGVD)[3] |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| Central Canal | | | | | | | |
| Reach 1 | 0035 | -0.1 | 0.0 | 0.0 | 005 | A1 | Varies - See Map |
| Dry Creek | | | | | | | |
| Reach 1 | 0020 | -1.9 | -0.1 | 0.0 | 020 | A4 | Varies - See Map |
| Deep Ponding | 0020 | -4.0 | N/A | N/A | 040 | A8 | 327 |
| Deep Ponding | 0015,0020 | -4.0 | N/A | N/A | 040 | A8 | Varies - See Map |
| Ponding | 0010 | N/A | N/A | N/A | N/A | AH | 351 |
| Ponding | 0010 | N/A | N/A | N/A | N/A | AH | 347 |
| Ponding | 0020 | N/A | N/A | N/A | N/A | AH | 332 |
| Ponding | 0020 | N/A | N/A | N/A | N/A | AH | 312 |
| Sheet Flow | 0010,0020 | N/A | N/A | N/A | N/A | A0 | Depth 1 |
| Dry Creek Canal | | | | | | | |
| Reach 1 | 0015,0020<br>0030 | -2.2 | -0.4 | 0.7 | 020 | A4 | Varies - See Map |
| Sheet Flow | 0020 | N/A | N/A | N/A | N/A | A0 | Depth 2 |
| Ponding | 0020 | N/A | N/A | N/A | N/A | AH | 298 |
| Fancher Creek Canal | | | | | | | |
| Reach 1 | 0035 | -0.5 | 0.0 | 0.0 | 005 | A1 | Varies - See Map |
| Sheet Flow | 0035 | N/A | N/A | N/A | N/A | A0 | Depth 1 |
| Ponding | 0035 | N/A | N/A | N/A | N/A | AH | 285 |
| Ponding | 0035 | N/A | N/A | N/A | N/A | AH | 284 |
| Ponding | 0035 | N/A | N/A | N/A | N/A | AH | 281 |

[1] Flood Insurance Rate Map Panel [2] Weighted Average [3] Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

## FLOOD INSURANCE ZONE DATA

CENTRAL CANAL-DRY CREEK-DRY CREEK CANAL-FANCHER CREEK CANAL

BlANK
PAGE

| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION (FEET NGVD)[3] |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| Herndon Canal | | | | | | | |
| Reach 1 | 0015,0020 | -0.5 | 0.0 | 0.0 | 005 | A1 | Varies - See Map |
| Sheet Flow | 0015,0020<br>0030 | N/A | N/A | N/A | N/A | A0 | Depth 1 |
| Deep Ponding | 0015,0020 | -4.0 | N/A | N/A | 040 | A8 | 306 |
| Deep Ponding | 0015 | -5.0 | N/A | N/A | 050 | A10 | 309 |
| Ponding | 0015 | N/A | N/A | N/A | N/A | AH | 292 |
| Deep Ponding | 0015 | -5.0 | N/A | N/A | 050 | A10 | 291 |
| Ponding | 0015 | N/A | N/A | N/A | N/A | AH | 289 |
| Ponding | 0015 | N/A | N/A | N/A | N/A | AH | 285 |
| Ponding | 0015 | N/A | N/A | N/A | N/A | AH | 281 |
| Mill Ditch | | | | | | | |
| Reach 1 | 0020 | -0.9 | -0.3 | 0.0 | 010 | A2 | Varies - See Map |
| Reach 2 | 0020 | -3.5 | -2.9 | 1.8 | 035 | A7 | Varies - See Map |
| Sheet Flow | 0020,0030<br>0035 | N/A | N/A | N/A | N/A | A0 | Depth 1 |
| Ponding | 0020 | N/A | N/A | N/A | N/A | AH | 329 |
| Ponding | 0020 | N/A | N/A | N/A | N/A | AH | 312 |
| Ponding | 0035 | N/A | N/A | N/A | N/A | AH | 289 |
| San Joaquin River | | | | | | | |
| Reach 1 | 0005 | -5.39 | -2.26 | 12.31 | 055 | A11 | Varies - See Map |
| Reach 2 | 0005,0010 | -3.52 | -1.54 | 8.44 | 035 | A7 | Varies - See Map |

[1] Flood Insurance Rate Map Panel [2] Weighted Average [3] Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

## FLOOD INSURANCE ZONE DATA

HERNDON CANAL-MILL DITCH-SAN JOAQUIN RIVER

| | |
|---|---|
| Zones A1, A2, A4, A7, A8, A10 and A11: | Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding. |

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Fresno is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Emergency Management Agency.

## 6.0 OTHER STUDIES

A feasability report on improvements for flood control and other purposes in the vicinity of the Fresno-Clovis urban-suburban complex was published in 1977 (Reference 2). It contained flood plain delineations and flow-frequency curves for the preproject 100-year flood on portions of Dry and Pup Creeks. The findings and presentations of the feasibility report and the current study are not in agreement due to differing approaches to hydrologic analyses and greatly differing scales and contour intervals of the topographic maps used to delineate flooded areas.

U.S. Geological Survey flood prone area maps (Reference 10) show flooded areas that represent a single historical flood that does not correlate with any of the hypothetical floods covered in this Flood Insurance Study.

In 1978, the U.S. Soil Conservation Service published a report (Reference 11) on flood hazard areas adjacent to Pup Creek and a portion of Dry Creek northeast of Fresno. The U.S. Soil Conservation Service report displayed water-surface profiles and presented floodflows for the 10-, 25-, 50-, 100-, and 500-year floods, and illustrated flooded areas for the 10-, 100-, and 500-year floods. Due to variations between the U.S. Soil Conservation Service report and findings and presentations of this study, representatives of the U.S. Soil Conservation Service and the U.S. Army Corps of Engineers met to discuss differences in flood profiles, flooded areas, and floodflows. Hydraulic differences were reconciled. Hydrologic variations were attributed to differences in criteria used to establish storm amounts, select loss rates, and develop unit hydrographs.

Because of the use of more recent data and more detailed study procedures, this Flood Insurance Study supersedes the previously published Flood Hazard Boundary Map for the City of Fresno (Reference 12).

Flood Insurance Studies for the unincorporated areas of Fresno County, California (Reference 13), and the City of Clovis, California (Reference 14) agree with the results of this Flood Insurance Study.

This study is authoritative for the purposes of the National Flood Insurance Program; data presented herein either supersede or are compatible with all previous determinations.

## 7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 211 Main Street, Room 220, San Francisco, California 94105.

## 8.0 BIBLIOGRAPHY AND REFERENCES

1. California Department of Finance, Population Estimates of California Cities and Counties, May 1979

2. U.S. Department of the Army, Corps of Engineers, Sacramento District, Feasibility Report for Water Resources Development, Redbank and Fancher Creeks, May 1977

3. U.S. Water Resources Council, Hydrology Committee, "Guidelines for Determining Flood Flow Frequency," Bulletin No. 17A, March 1976 (Revised 1977)

4. U.S. Department of the Army, Corps of Engineers, Sacramento District, Hydrograph Routing and Rating Analysis Computer Program, unpublished

5. U.S. Department of the Army, Corps of Engineers, Sacramento District, Standard Project Criteria for General and Local Storms, Sacramento-San Joaquin Valley, California (Draft Report), April 1971

6. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Generalized Computer Program, Davis, California, October 1973

7. Fresno Metropolitan Flood Control District, Topographic Maps, Fresno County, California, Scale 1:2,400, Contour Interval 1 foot, August 1974

8. Fresno County Planning Department, Topographic Maps, Scale 1:9600, Contour Interval 2 feet: Clovis, California (1974) (Aerial photography flown November 25, 1974)

9. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Fresno County, California (Unincorporated Areas), Scale 1:24,000, January 9, 1979

10. U.S. Department of the Interior, Geological Survey, Flood-Prone Area Maps, Fresno County, (Various Dates)

11. U.S. Department of Agriculture, Soil Conservation Service, Flood Hazard Analyses, Northeast Fresno, Fresno County, California, August 1978

12. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Fresno, California, Scale 1:12,000, Revised November 28, 1978

13. Federal Emergency Management Agency, Flood Insurance Study, Fresno County, California (Unincorporated Areas), unpublished

14. Federal Emergency Management Agency, Flood Insurance Study, City of Clovis, California, unpublished

California Department of Finance, California Statistical Abstract, 1970, Sacramento, California, 1971

California Department of State, California Roster, 1979-1980, Sacramento, California, 1979

Fresno County, Fresno County General Plan, 1975

Hoover, Mildred B., Rensch, Hero E., and Rensch, Ethel G., Historic Spots in California, Stanford University Press, Stanford, CA, Third Edition, 1966

U.S. Department of the Army, Corps of Engineers, Sacramento District, Office Report, Hydrology, Big Dry Creek Reservoir and Diversion, June 1973

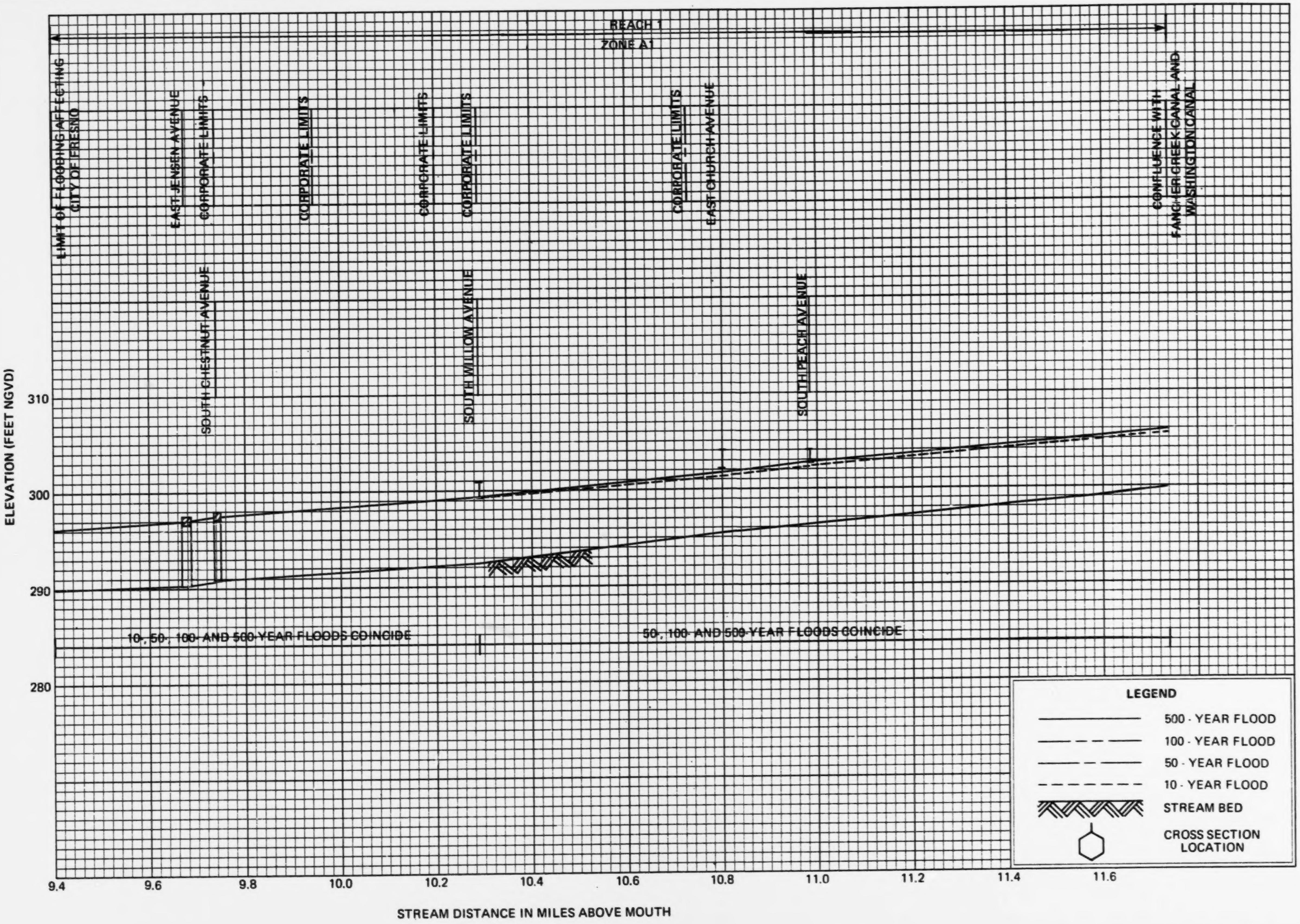
U.S. Department of the Army, Corps of Engineers, Sacramento District, Office Report, Hydrology, Redbank and Fancher Creeks, September 1972 (Revised April 1973)

U.S. Department of the Army, Corps of Engineers, San Joaquin Basin, California, Fresno County Flood Insurance Study, Cross Sections, File Nos. 7-10-1811 to (and including) 7-10-1821 and 7-10-1823 to (and including) 7-10-1826, December 1977

U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Clovis, California (1964), (Photorevised 1972); Fresno North, California (1965), (Photorevised 1972); Fresno South, California (1963), (Photorevised 1972); Kearney Park, California (1963); Malaga, California (1964), (Photorevised 1972)

Vandor, Paul E., History of Fresno County, Historic Record Company, Los Angeles, California, Two Volumes, 1919

Winchell, Lilbourne A., History of Fresno County and the San Joaquin Valley, A.H. Cawston Publisher, Fresno, California, 1933



**FLOOD PROFILES**

CENTRAL CANAL

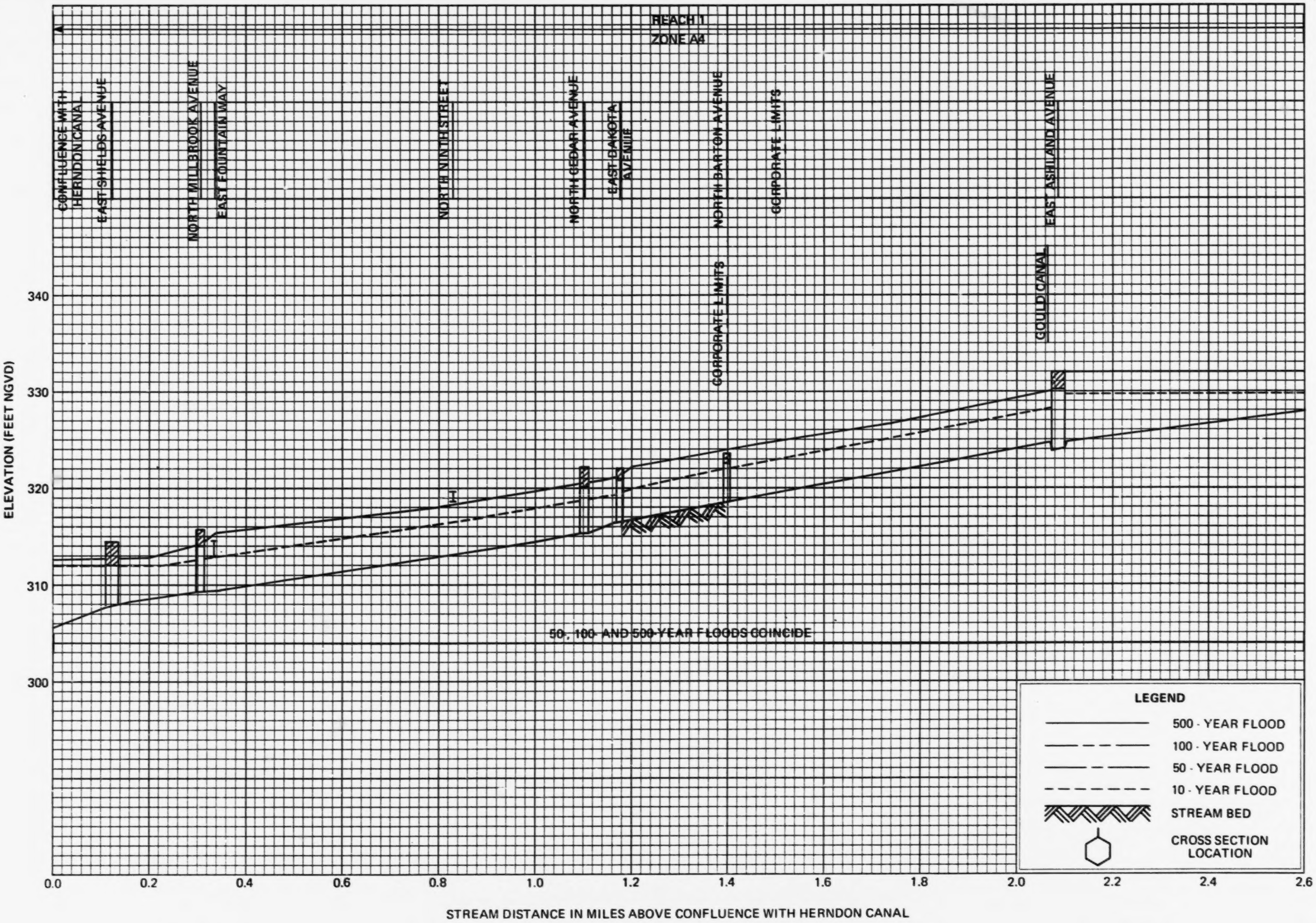
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

**01P**

26

BEST DOCUMENT AVAILABLE



# FLOOD PROFILES

## DRY CREEK

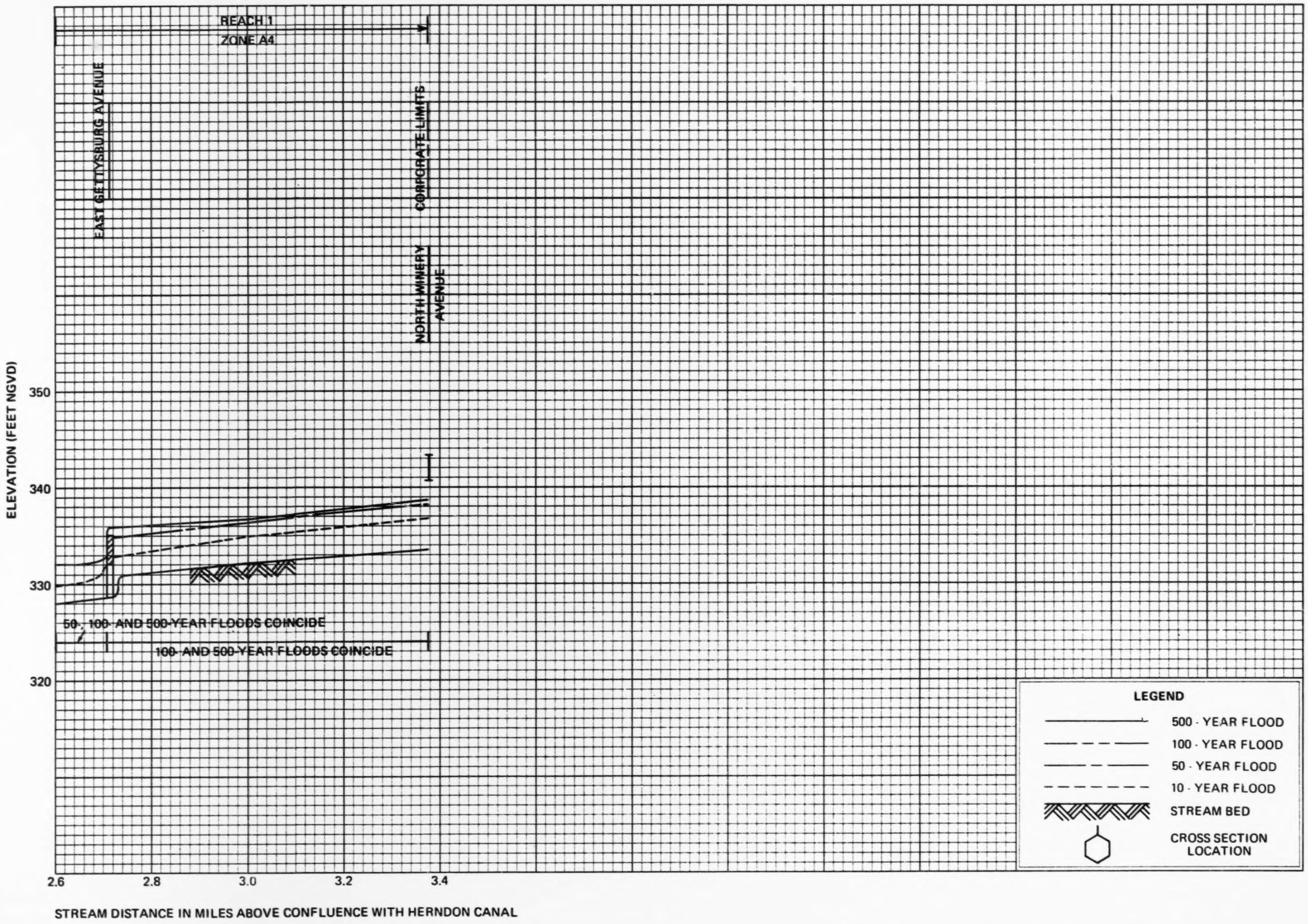
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

02P

27

BEST DOCUMENT AVAILABLE



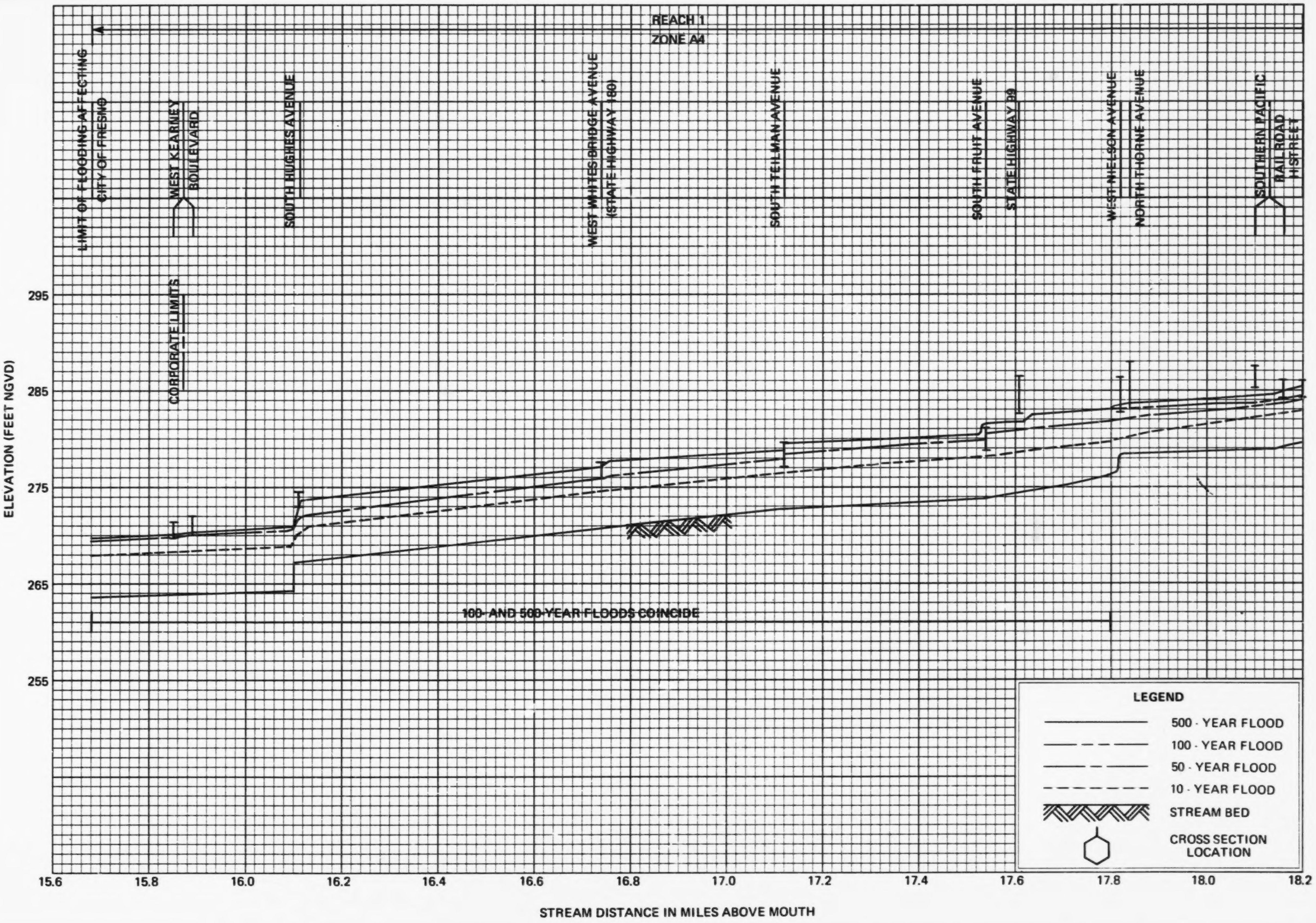
# FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

03P



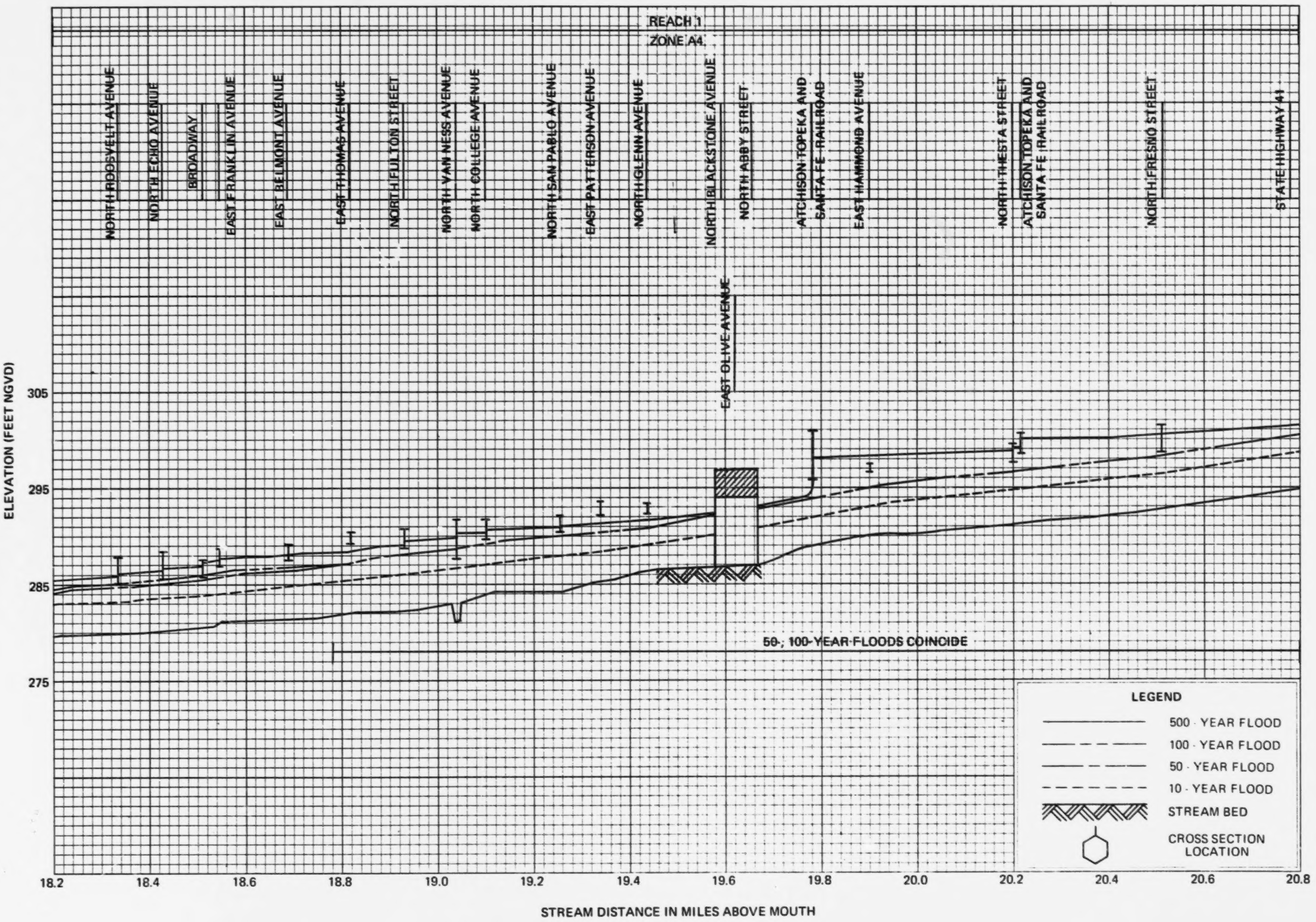
# FLOOD PROFILES

DRY CREEK CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

04P



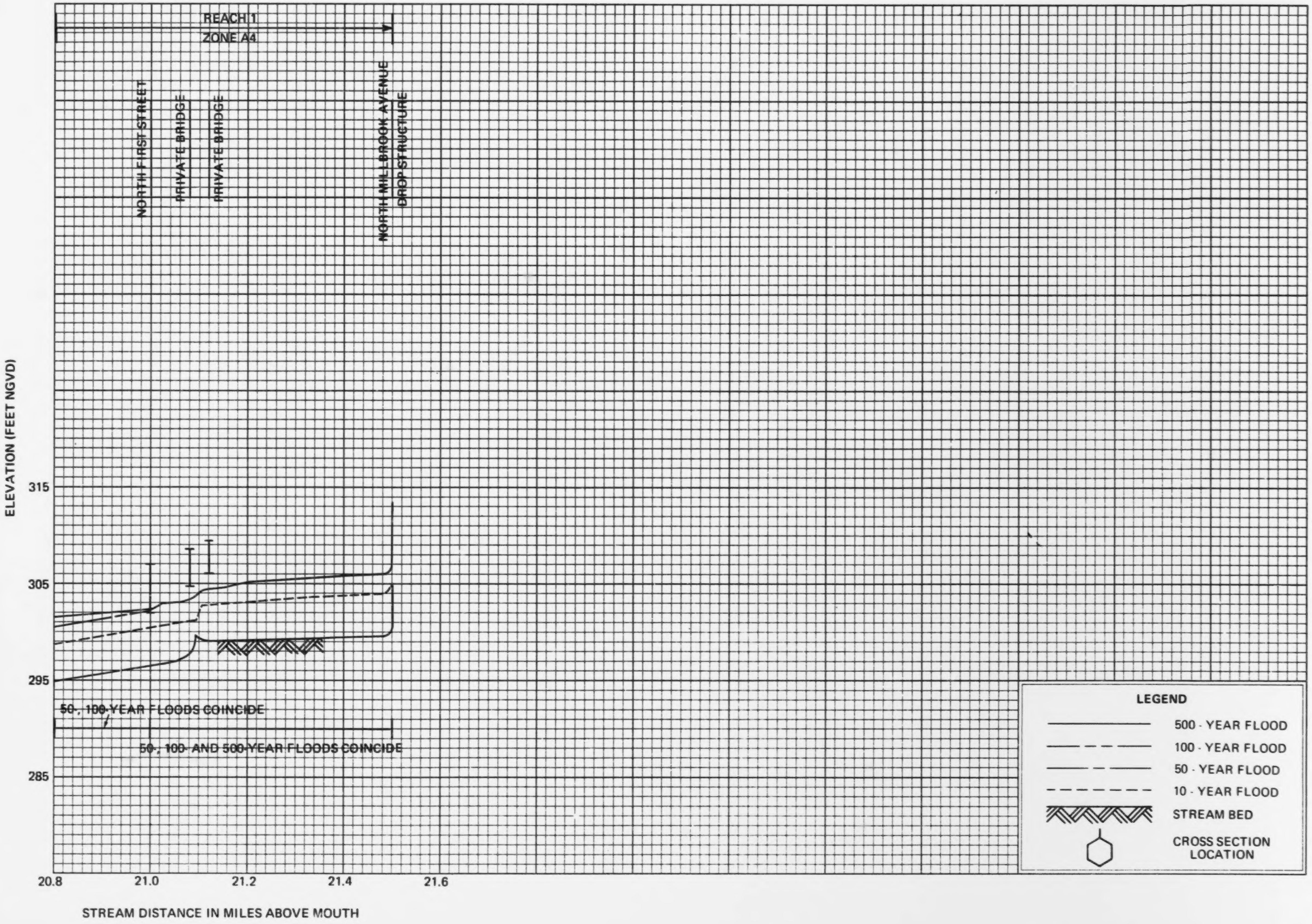
# FLOOD PROFILES

DRY CREEK CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

05P



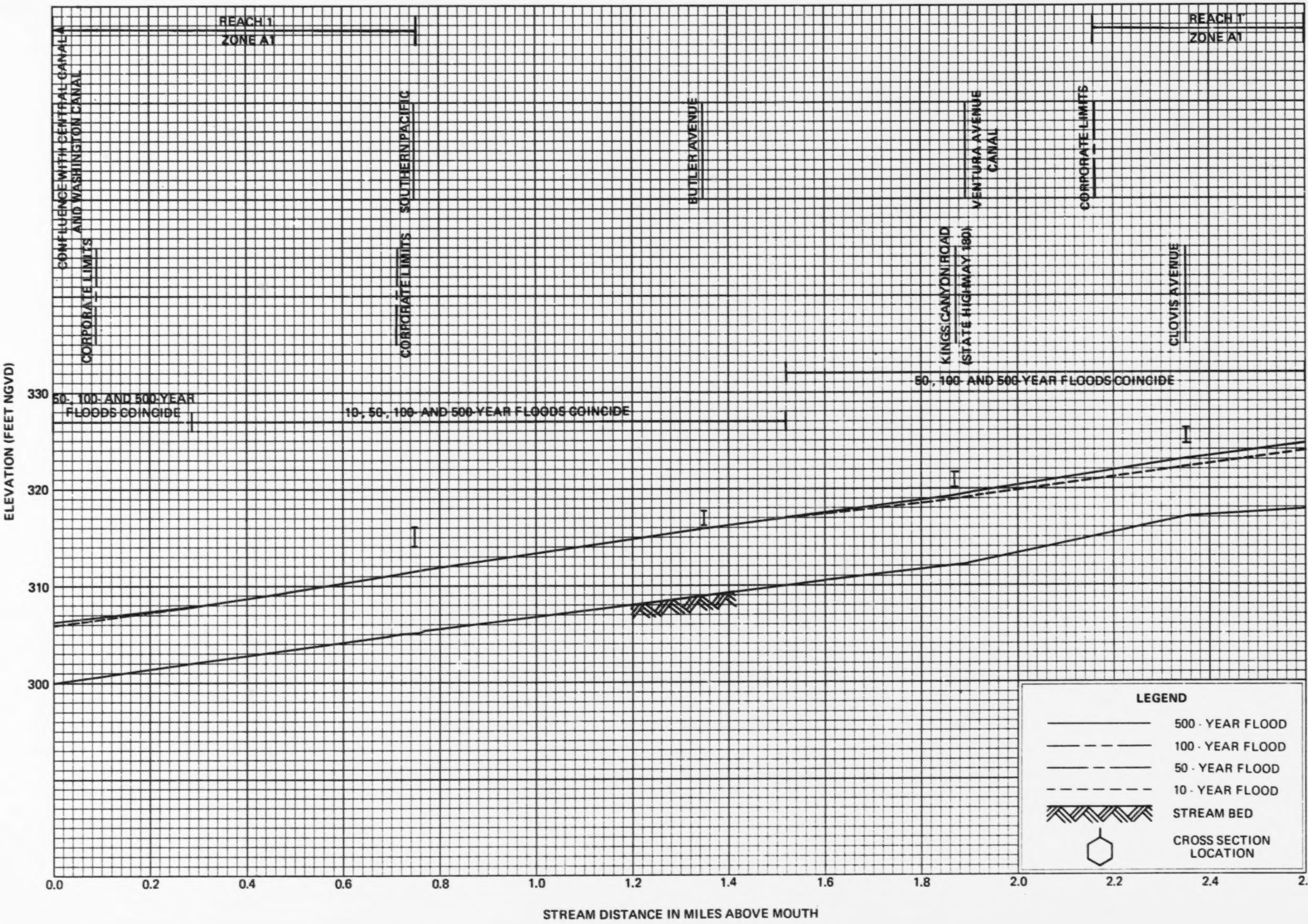
# FLOOD PROFILES

DRY CREEK CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

06P



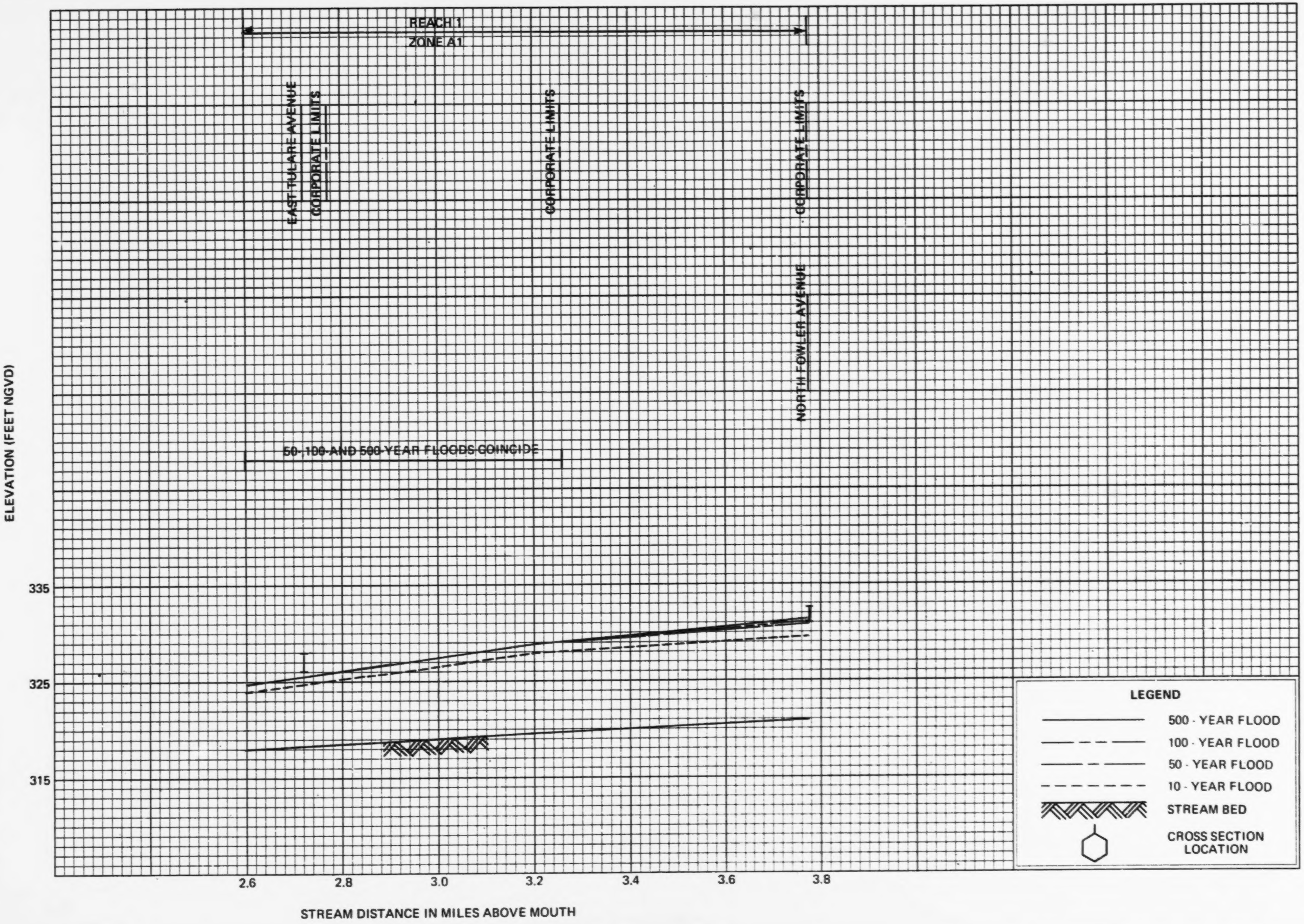
**FLOOD PROFILES**

**FANCHER CREEK CANAL**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

**07P**



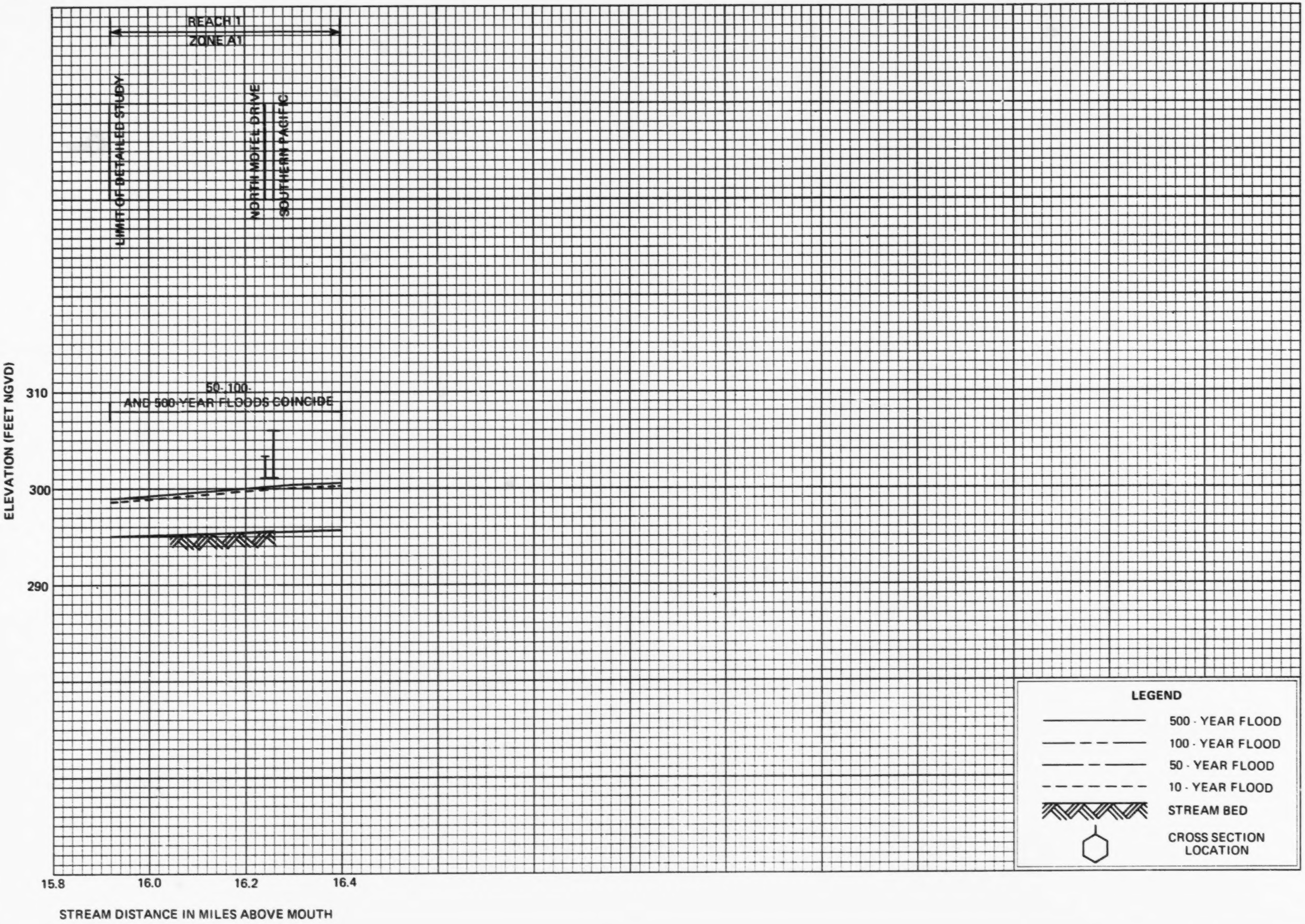
# FLOOD PROFILES

FANCHER CREEK CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

08P



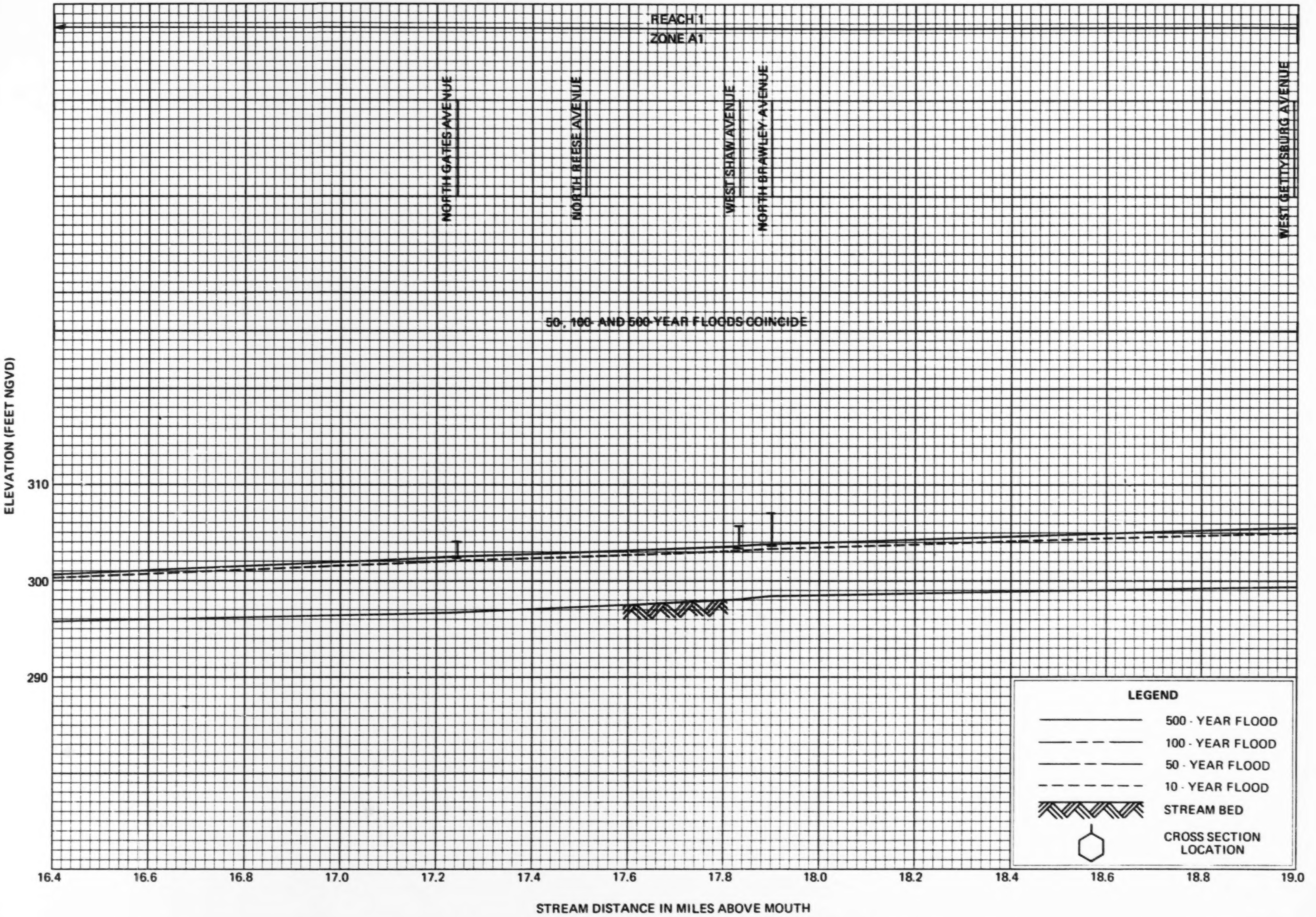
**FLOOD PROFILES**

**HERNDON CANAL**

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

**09P**



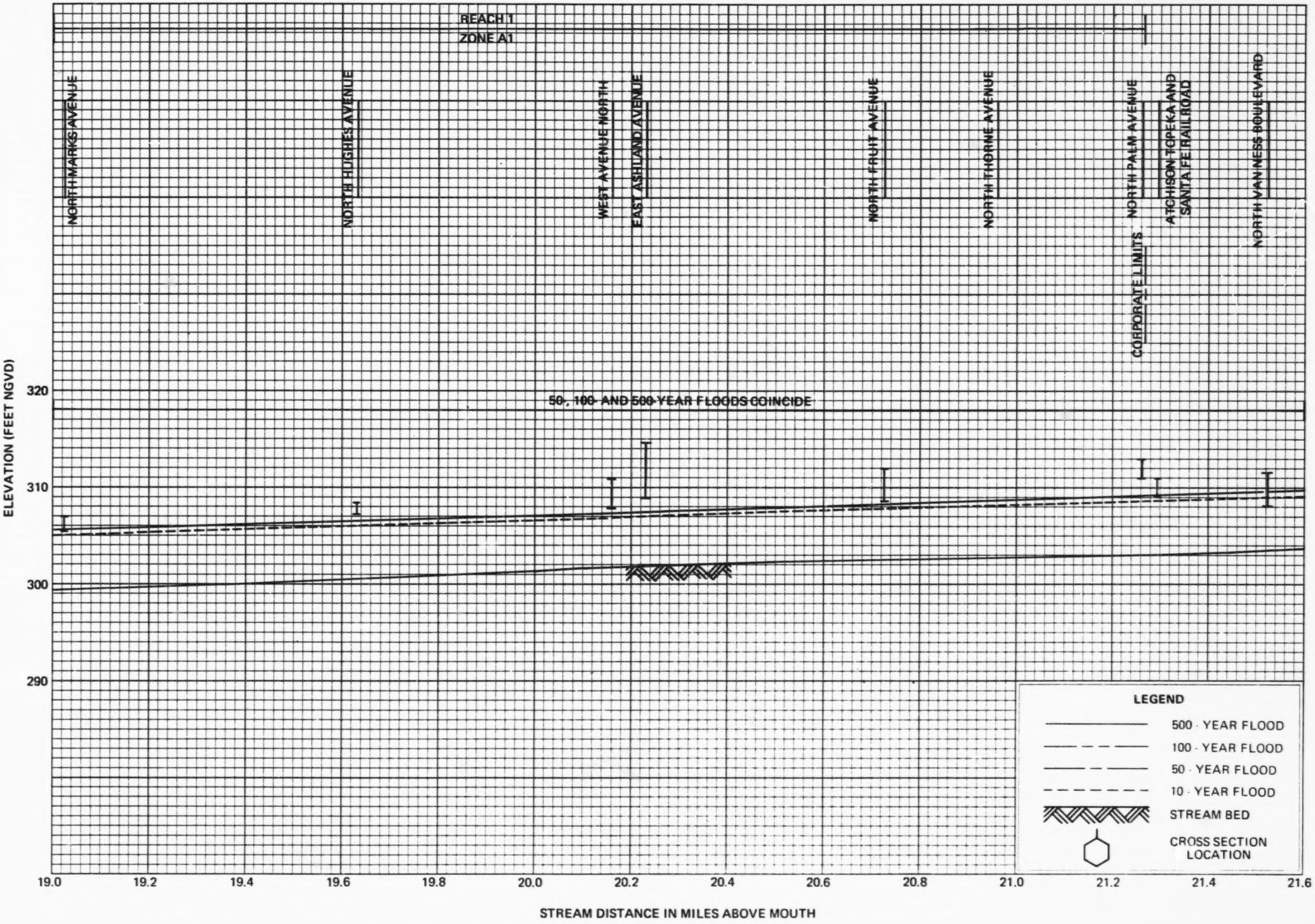
**FLOOD PROFILES**

**HERNDON CANAL**

**FEDERAL EMERGENCY MANAGEMENT AGENCY**

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

**10P**



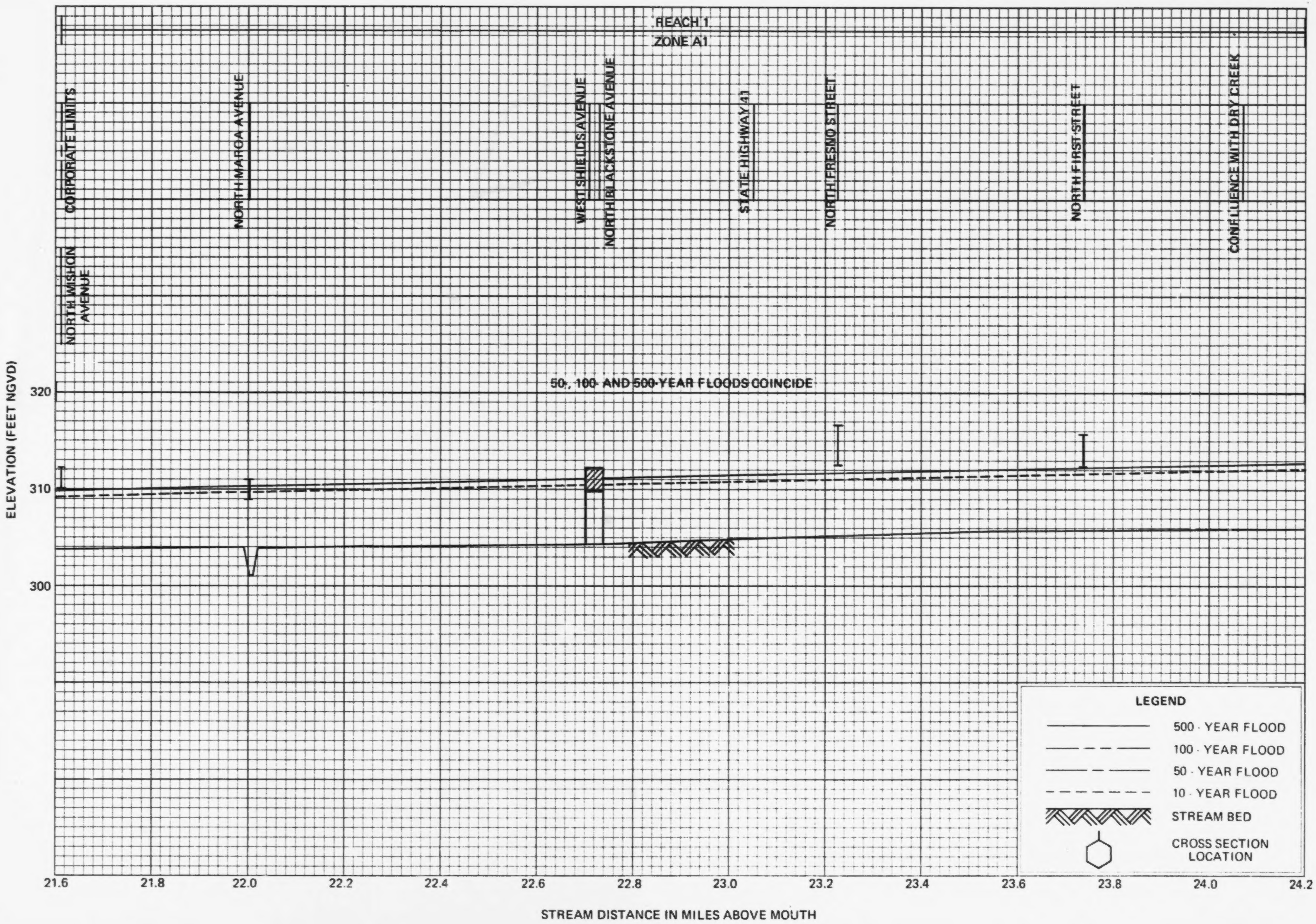
**FLOOD PROFILES**

**HERNDON CANAL**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

**11P**



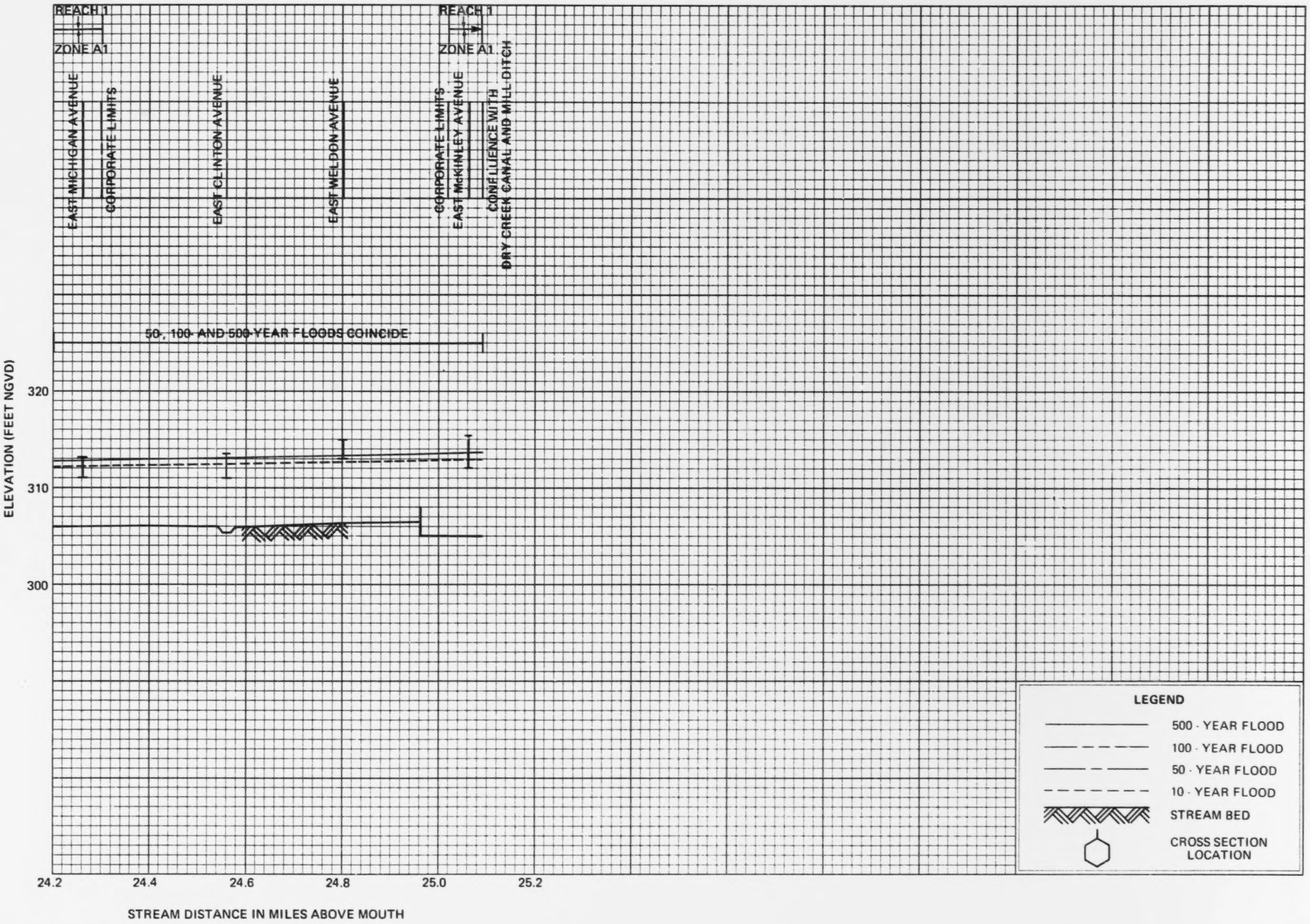
## FLOOD PROFILES

HERNDON CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

12P



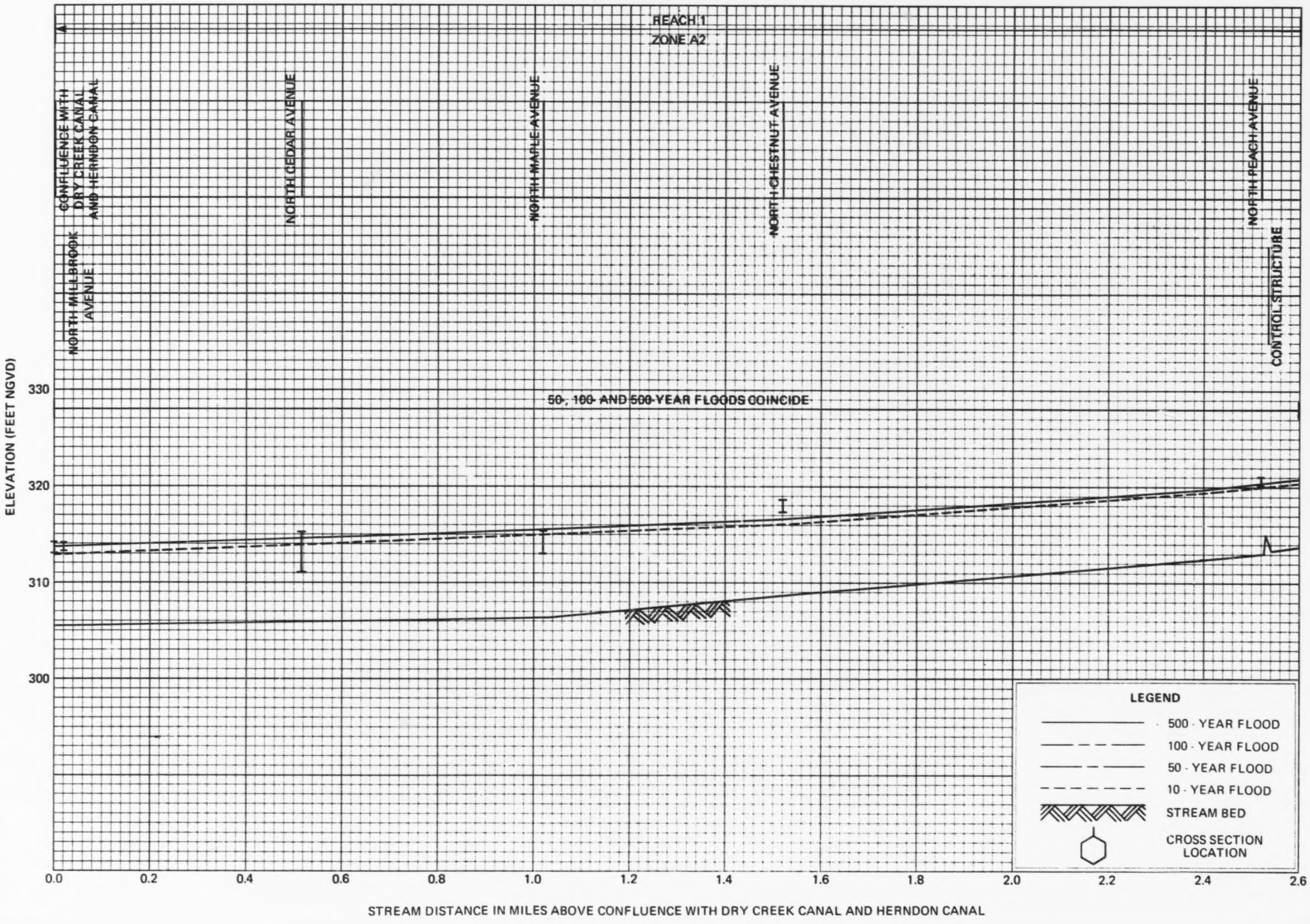
## FLOOD PROFILES

HERNDON CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

13P



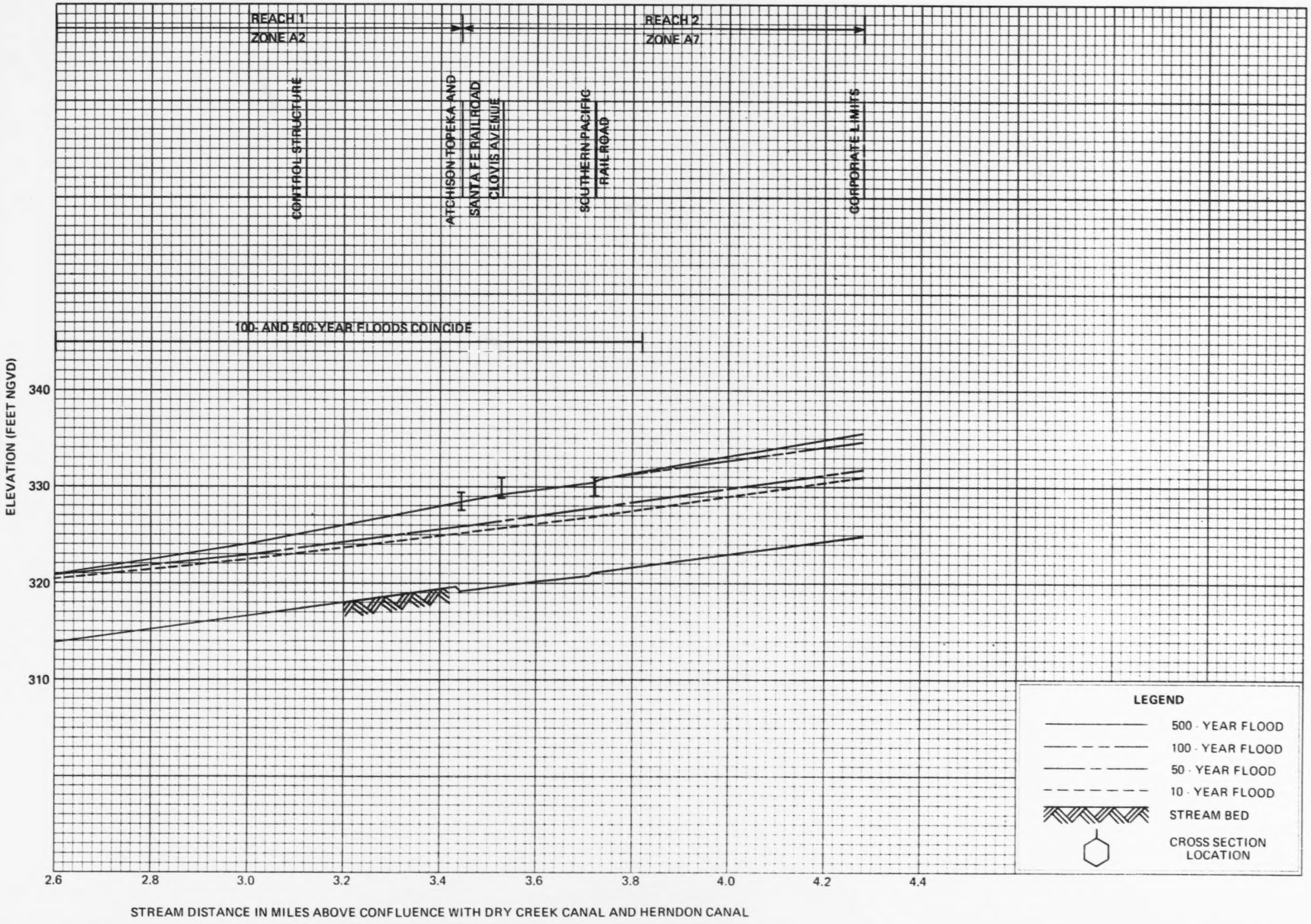
## FLOOD PROFILES

MILL DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

14P



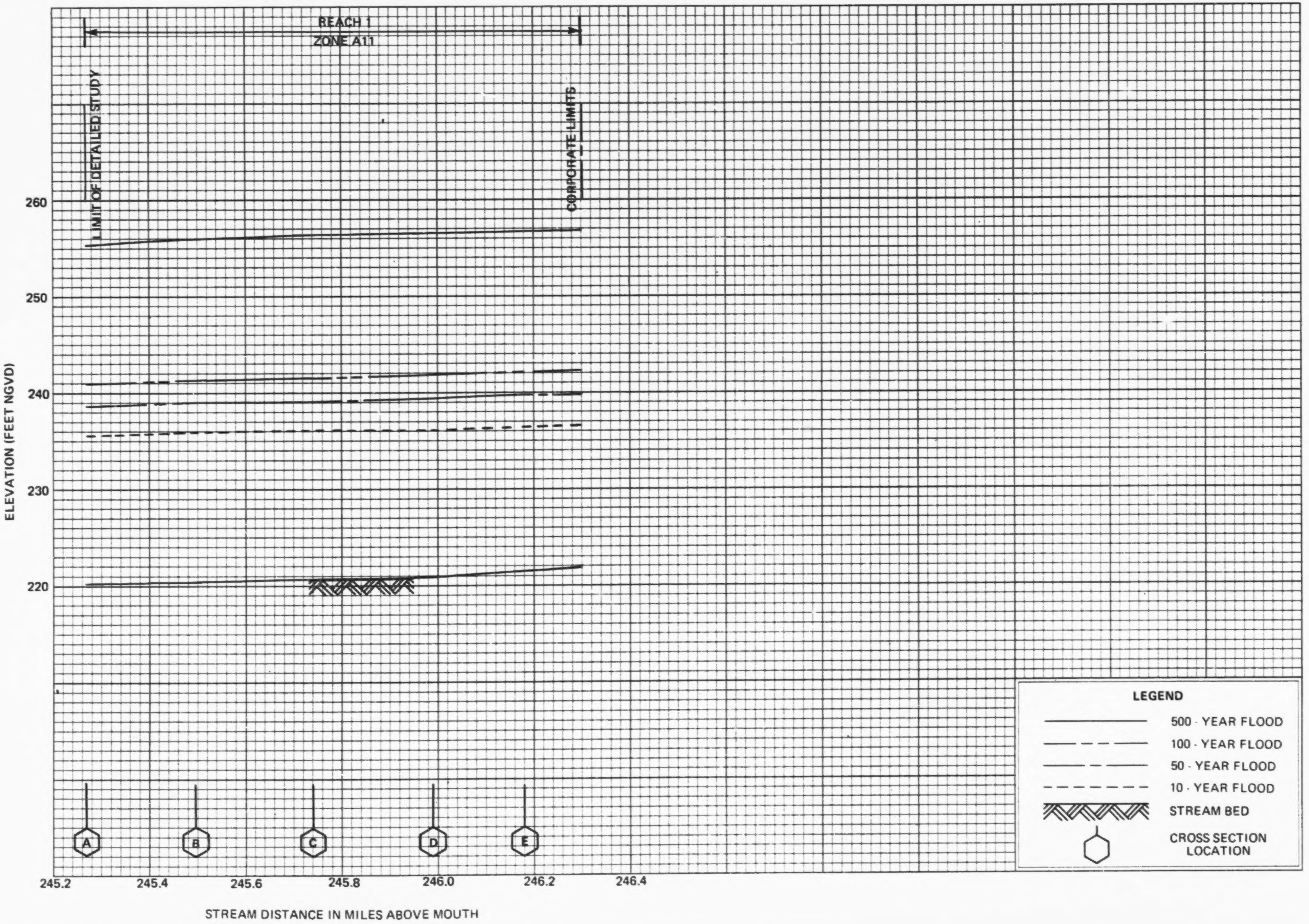
**FLOOD PROFILES**

MILL DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

**15P**



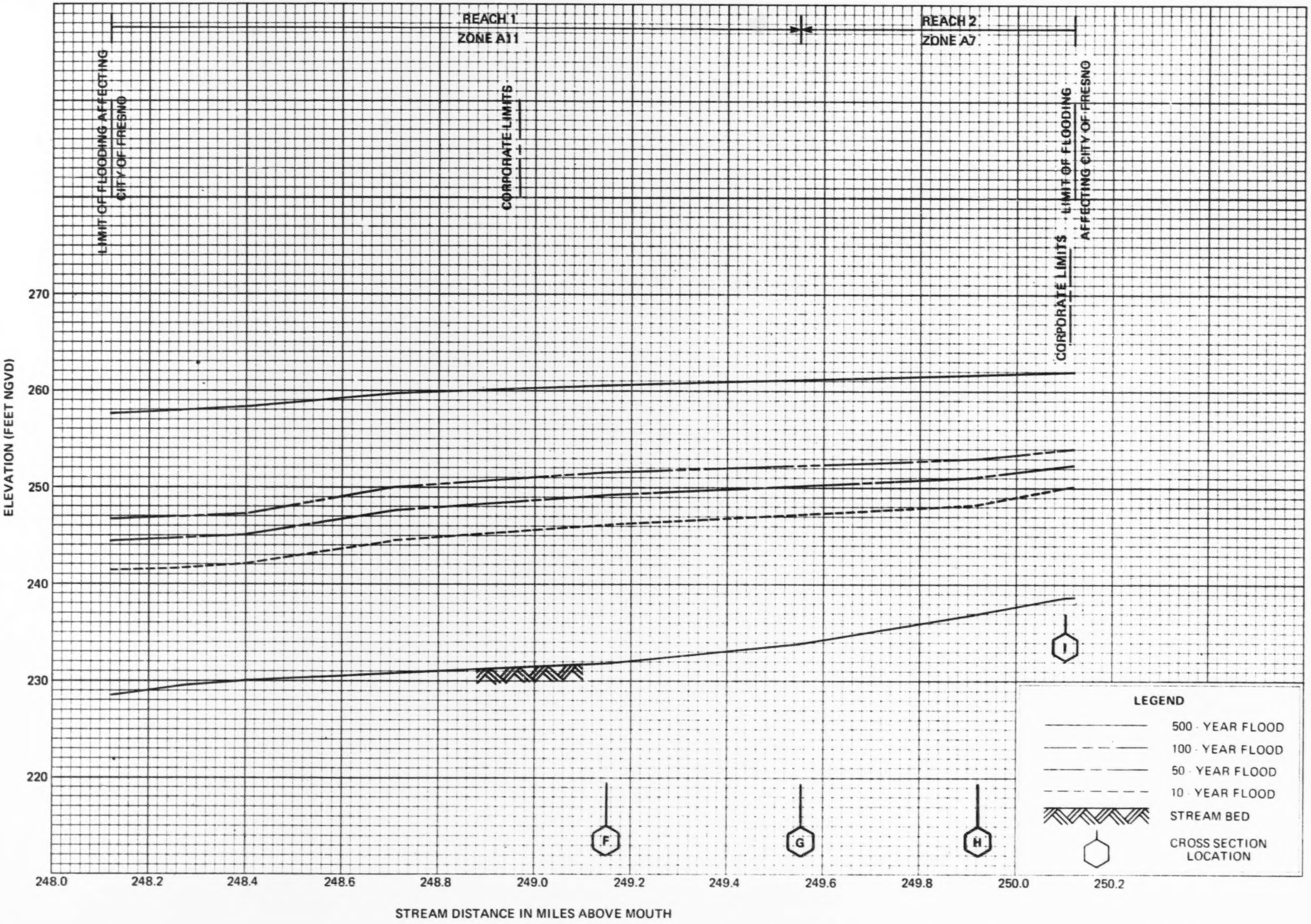
**FLOOD PROFILES**

SAN JOAQUIN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

**16P**

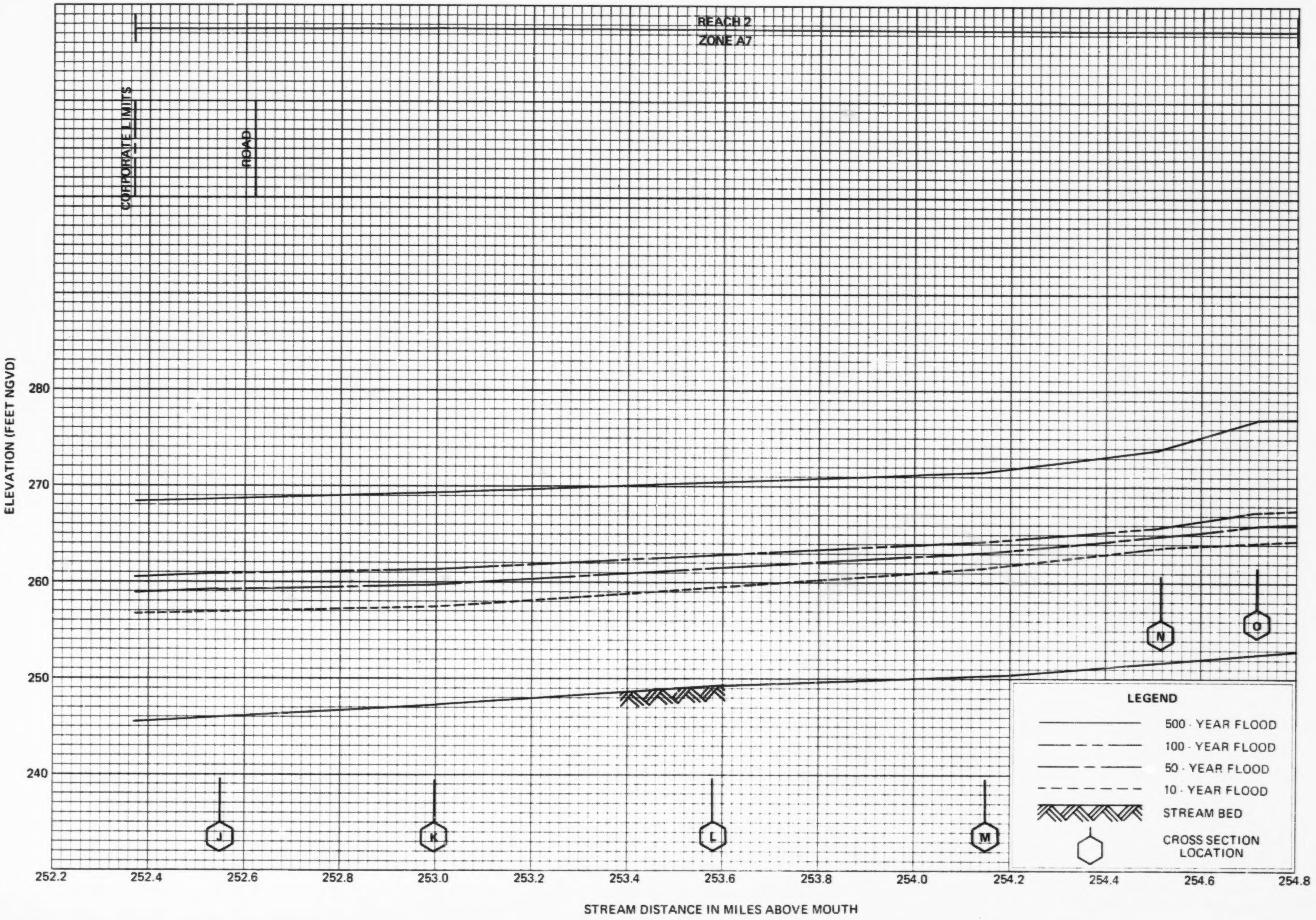


**FLOOD PROFILES**

**SAN JOAQUIN RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)



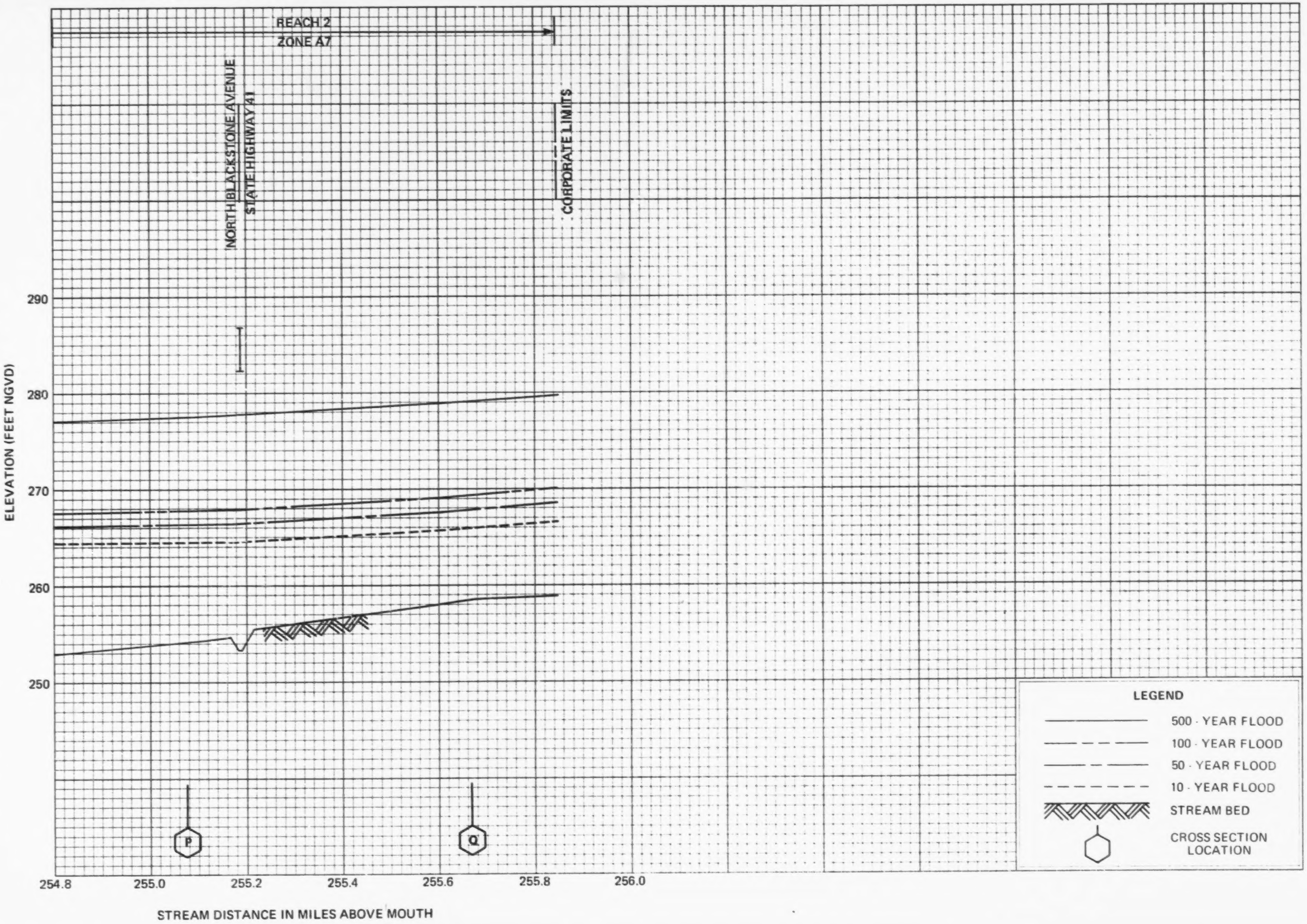
**FLOOD PROFILES**

**SAN JOAQUIN RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF FRESNO, CA**
**(FRESNO CO.)**

**18P**



**FLOOD PROFILES**

SAN JOAQUIN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF FRESNO, CA
(FRESNO CO.)

**19P**